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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 1061

Contribution from the Forest Service
WILLIAM B. GREELEY, Forester

Washington, D. C. July 29, 1922

LONGLEAF PINE

By

WILBUR R. MATTOON, Forest Examiner

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A well-stocked, second-growth longleaf pine stand, 70 years old, on a farm in Tattnall County, Ga. The trees average about 70 feet in height and range up to 15 inches in diameter; they contain a total of about 30,000 board feet per acre of saw timber. The present owner grew up on the farm and remembers the trees when they were saplings about 10 years old. The location is within a few miles of the railroad, and attractive offers have repeatedly been made to the owner for the timber to be used as piling and lumber and for turpentining. Fires have largely been kept out.

FIG. 1.—Here is going on the complete removal of the forest cover with no hope of its returning naturally. After being cupped for two years, practically every pine is cut for saw timber or pulpwood. The tops and culls are being worked up into pulpwood; but regrettably, all the small young trees down to 4 inches are being taken. This type of logging, with the exception of the close utilization, is widely practiced over the longleaf belt.

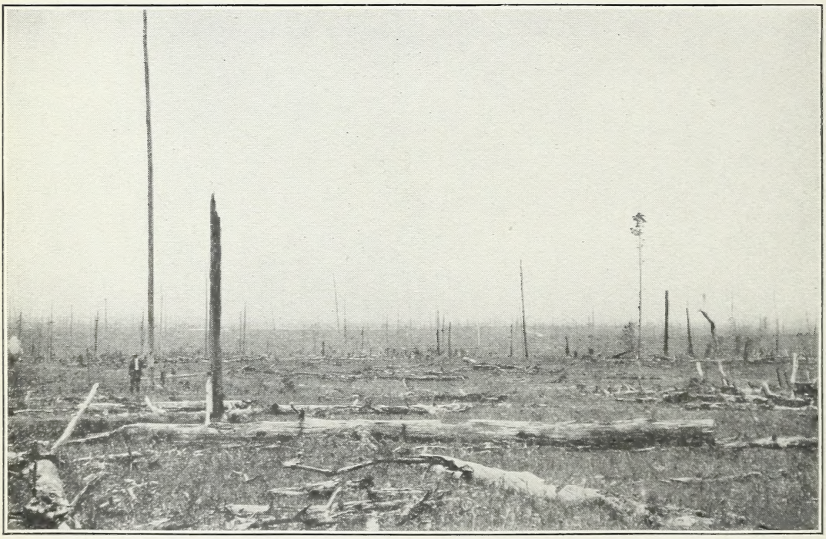

FIG. 2.—The South has some 30,000,000 acres of waste and idle land suitable for producing 100 to 400 board feet of longleaf pine yearly, together with a steady yield of turpentine. In the development of the country's resources these lands are bound to be among the South's greatest assets.

THE PASSING OF THE LONGLEAF FOREST.

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Longleaf pine is a southern forest tree of great economic importance. It is one of our best timber trees, and from it is derived the bulk of the turpentine and rosin produced in this country. With the rapid disappearance of old-growth timber, the increasing use of low-grade lumber, and the rising values of all forest products, second-growth pine is coming to be an asset of increasing importance.

Large areas of cut-over lands are being handled in connection with the farming and grazing industries. On account of the natural wide spacing of longleaf pine trees, the grazing of live stock can be successfully carried on along with the growing of timber, without injury to either industry, as a double source of return from the land. Almost daily new uses and new values are being found for forest products formerly considered valueless. Questions on how to get the most profit from second-growth pine are being frequently asked. To the owner of large timber holdings, as well as to the farmer, the importance and value of second-growth pine are coming to be matters of increasing consideration.

The common belief that longleaf pine is slow growing applies only to old-growth or mature timber, and to that growing on unfavorable situations, such, for example, as the very dry sand hills and the flatwoods. It is likewise true of stands that are burned frequently, and of those that are overcrowded and in need of thinning. The seed germinates quickly—usually in two to four weeks after it matures in the fall. Contrary to the popular belief, when sufficient seed trees are left, young longleaf comes in extensively on cut-over lands, but the great bulk of it is killed by fires and hogs.

Longleaf pine is, however, remarkably resistant to fire. Millions of young trees not over 25 years of age have undoubtedly passed

through as many as 10 fires. Each fire, however, takes its toll of living trees and injures and retards the growth of all the others. Of the trees which survive, large numbers are being bled for turpentine or cut for timber at much too young an age to get the best money returns. Protection and forest management mean increased timber growth and increased profit.

Destructive lumbering and destructive fires are every year creating in the southern pine region millions of acres of waste and barren lands. In these idle timber lands is an enormous potential wealth, and their productive power is not fully realized. Economically, this condition is an unsettling factor just as serious as the idleness of thousands of farms or of factories. Forest growth should be encouraged on waste or idle lands and on lands not now in demand for agricultural use and not likely to be during the next half century, whether on farms or large cut-over tracts.

This bulletin deals not only with the forest conditions on the upper or higher portions of the Coastal Plain, where farming is relatively important, but it is also applicable to the flatwoods, where only 10 to 15 per cent of the land is in farms and the remainder mostly in the ownership of large lumber companies. Little attention will be given to old-growth timber, which is rapidly passing. The aim is to present the more useful information pertaining to the growth and value of longleaf pine, the production of timber and turpentine, the methods of cutting, reforestation, and protection of second-growth longleaf pine, and the ways of making tracts of land profitable which will remain idle for many years unless they are devoted to growing crops of turpentine and timber.

RANGE AND IMPORTANCE.

Longleaf pine is generally well known in the localities where it grows and is commonly distinguished from other species with which it is associated. In earlier life, the erect, stout, central stem, densely covered with leaves ("straw"), is one of its well-known characteristics. Later and through life it has a straight, clean shaft or trunk. The leaves are from 8 to 18 inches in length, pendulous, and occur in crowded clusters of three leaves each, forming the familiar-looking tufts toward the ends of the branches (Pl. III). The terminal buds are very large and almost white. The cones ("burrs") vary in length from 6 to 10 inches—the longest of any of the southern pines—and, like all the pines, require two full seasons to reach maturity. The bark is orange-brown, and in mature trees separates on the surface into large, flat, irregular-shaped plates (Pl. IV) made up of thin scales. Fully grown trees reach heights of 70 to 120 feet, and diameters of 2 to 2½ feet or occasionally 3 feet. The trunk is notably straight, slightly tapering, and usually clear of limbs for one-half to two-thirds of its length.

The natural range of long-leaf pine (fig. 1) extends from southeastern Virginia, southward over the Atlantic and Gulf Coastal Plain to Florida and westward to eastern Texas. Commercially the range is very much less extensive. As a result of lumbering and repeated fires, there remains to-day probably less than one-fifth of the original stand of long-leaf pine, estimated to have amounted originally to over 400 billion board feet.

The largest remaining areas of old growth are found in the five States bordering on the Gulf of Mexico. Reports from mill operators

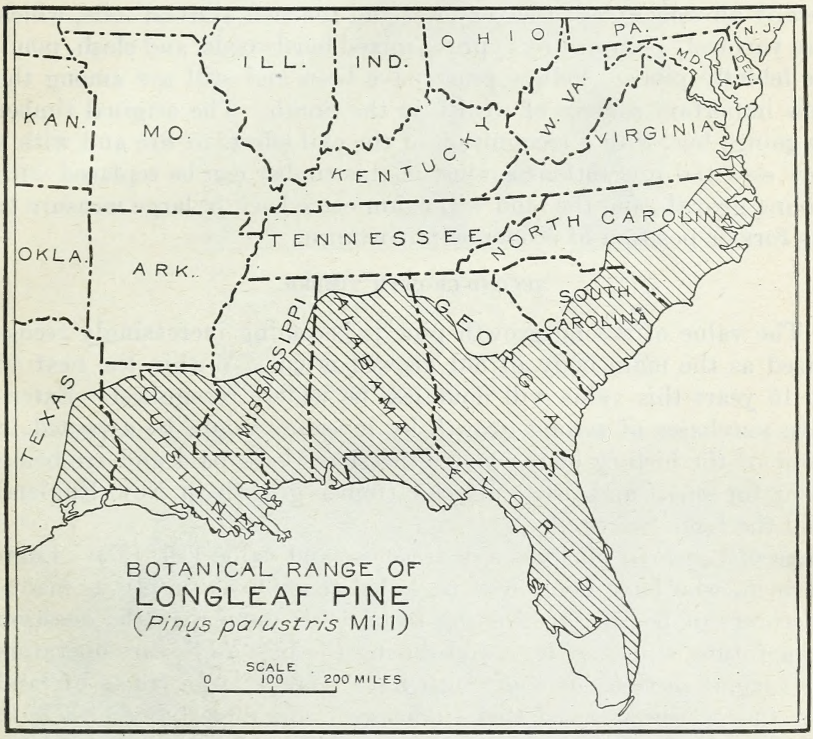


FIG. 1.—Outline map of the southern United States, the shaded part showing the botanical range of longleaf pine. This species of southern pine occurs widely distributed over the Coastal Plain from southeastern Virginia to eastern Texas. Extensive areas of cut-over longleaf lands occur throughout practically the whole range. The bulk of the remaining old growth is located in parts of Florida, Alabama, Mississippi, and Louisiana. Originally, longleaf pine composed the bulk of probably the world's greatest pure yellow pine forest.

owning or controlling practically the entire remaining stand of old-growth pine in the South indicate that it is very doubtful whether at the present rate of cutting the longleaf forests, which have always been the chief factor in the production of southern yellow pine, will last for many years.

The total annual cut of longleaf is not known. According to the best estimates, the lumber cut is roughly about one-half of the total southern yellow pine lumber cut, which ranges yearly from 10 to 15

billion board feet. In addition, considerable amounts are cut for crossties, piling, pulpwood, and fuelwood. The estimated total cut is, therefore, equivalent to 8 to 10 billion board feet. Continuous losses of merchantable timber are caused by windfall, turpentining, insects, fires, and diseases.

Its habit of growth in pure stands over large areas, rather than as scattered trees in a mixture, and its ability to grow on poor, dry, and poorly drained soils mark longleaf as a pine of great potential value. Over its range, generally, longleaf pine is found growing on practically all soils except the very wet and the rich alluvial soils, which are variously occupied by cypress, mixed hardwoods, and slash, pond, or loblolly pines. Yellow pines have been and still are among the few important sources of wealth in the South. The original timber is going; but, with a recognition of the evil effects of fire and with a few essential precautions against it, this timber can be replaced with young growth, and the land will again come back in large measure to its former position of economic importance.

SECOND-GROWTH TIMBER.

The value of second-growth pine is becoming increasingly recognized as the main body of old growth is cut. Within the next 10 to 15 years this value will doubtless be widely recognized. Extensive purchases of second growth by investors might be expected in view of the history of the prices that have been paid and are being paid for small and often inferior timber growth in New England and the Lake States.

Second-growth pine has a distinct use and value (Pl. IV). Lumbermen, who have heretofore regarded themselves simply as manufacturers of boards, are coming to have an interest in the question of a future supply of logs, and during the past few years operators in various sections of the South have bought large tracts of land for the perpetuation of their industry. The underlying idea is to operate continuously on the same tract. The more progressive lumbermen regard favorably the buying of good stands of young timber because it affords a more profitable investment than holding old timber for 20 to 40 years. A relatively small amount of capital is tied up in the combined young timber and cut-over land, and often a greater return on the investment is possible.

Growth in mature timber is very slow and is offset by losses caused by insects, fungous diseases, fire, wind, and lightning. Young timber, on the other hand, is growing at a good rate and utilizing the productive capacity of the land. Merchantable stands are coming to be taxed at an amount nearer their full value. In young stands the trees that need to be cut out, in order to allow the remaining trees ample room for growth, yield cordwood, ties, poles, or pulp-

FIG. 1.—A heavy crop of longleaf pine cones bearing seed occurs widely over the South at intervals of about every 7 years. The flowers "set" early in the spring; the seeds require 2 years to mature, and are usually shed in September. Seed crops can thus be foretold more than a year ahead by observing the small green cones on the trees in the summer and fall during their season of devlopment.

FIG. 2.—Foliage and cones ("burrs") of the longleaf pine.

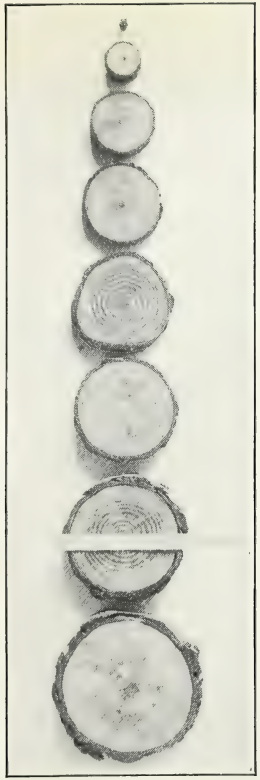


FIG. 1.—Sections cut from the average-sized tree in a well-stocked 48-year-old longleaf stand. (Plate IX, Fig. 2.) The tree measured 62 feet in height and 11 inches in diameter (outside bark) at breastheight.

FIG. 2.—Products from farm timberland. This 40-year-old longleaf pine stand has for years supplied the owner with timber, wood, and pine straw. Located on a ridge of thin soil, in Telfair County, Ga., it has at the same time served as a protective windbreak. Note the even spacing and uniform development of the trees, the result of the owner's commendable practice of thinning out the poorer, suppressed, and crooked trees.

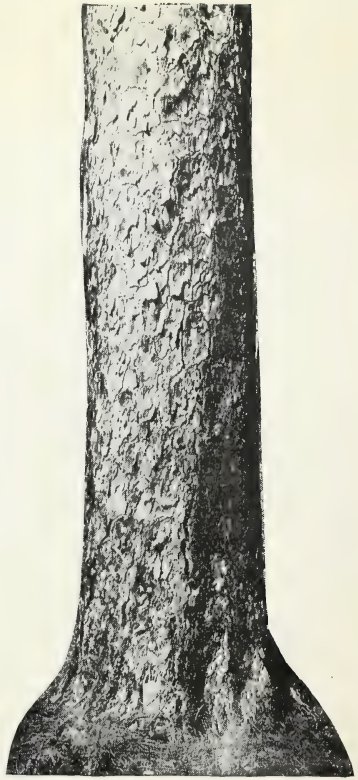


FIG. 3.—The smooth straight trunk of longleaf pine is well known over the range of its occurrence. One of its associates, slash pine, has a quite similar bark, while that of loblolly, another associated pine, is rough, with deep longitudinal furrows and ridges. Young-growth pine exhibits quite similar differences in the appearance of the bark.

wood. Under "Cutting" the subject of thinning is discussed. Operators of turpentine have learned that second growth serves the purpose. Over considerable sections of the yellow pine region the lumber industry is now working on second growth.

Extensive areas in the South will not be put to their best use until they are growing well-stocked stands of young timber. It is inconceivable that a section of the country with such a vast area of natural forest soil could continue for any length of time in a state

> One sawmill, that cuts mostly longleaf pine, requires daily the timber from about 100 acres, or yearly that from about 25,000 acres. About 6,000,000 acres of longleaf pine timber land, it is estimated, are cut in this country yearly, and about 4,000,000 acres are left fire-swept and practically idle. Is it not time steps were taken to remedy this situation? It is not a question of decreasing the rate of cutting the timber, but rather of stopping fire devastation and putting the nonproducing acres to work. Millions of acres of lands now denuded and nonproductive should be growing trees of use and value.
>
> The supplies of coal, petroleum, and iron are limited, but not so with wood. A forest is not a thing to be exploited and then abandoned, but a property that under right management can be made to yield fair annual dividends in perpetuity.
>
> Lumber should be among the cheapest of commodities, since with adequate forethought and care the forest becomes, like the air, water, and soil, an inexhaustible resource.

of prosperity with timber growing largely eliminated. Any sound economic policy for the region calls for the right use of the present forest resources and also for the adoption of public measures which will insure an income from all lands and a permanent supply of the raw products so essential to the progress and prosperity of the people. Cut-over forest land can be made to produce another forest as good or better than the original one. It thus follows that the use of timber and the reproduction of timber can go hand in hand, provided, of course, that the right steps are taken in accordance with the natural laws of tree growth.

Cut-over lands on which there are seed trees are worth more than denuded lands, for the reason that they are earning an income from the growth of the trees, which is accelerated by the increased supply of light and soil moisture, and from the constantly enhancing value of the young forest stands. It is claimed by some practical lumbermen that the value of such lands with young growth will be doubled within about 5 years after logging. These factors do not diminish the prospective value of these lands for agriculture or interfere to an appreciable degree with the use of the land for grazing. Lands that contain some timber are more valuable for farms than are "skinned" cut-over lands, because a supply of timber is available for sale and for home use, there is shade in the pastures, and the trees make the homes more attractive.

RATE OF GROWTH.

During the first 30 to 60 years of its life—the period under special consideration in this bulletin—and on the better soils or situations where it occurs, longleaf pine grows at a moderate to rapid rate. The general rating of longleaf as a slow-growing species of pine is the result of the almost exclusive handling and consideration of old timber, which grows at a slow or very slow rate.

The rate of growth shows wide variations, apparently related closely to differences in the depth and texture of the soil and its supply of soil moisture. Because many of the longleaf pine soils are subject to periods of extreme dryness, the slow growth in many natural unthinned stands and the comparatively wide spacing found in older longleaf stands are often attributed to the competition of the roots for soil moisture rather than of the branches for light. An important determining factor in the rate of growth of the individual trees is their density, or the number of trees per acre in the stand, at any specified age. Growth in diameter is particularly influenced by this condition.

During the first few years the growth of young seedlings consists chiefly in the development of a large root system. A very stout long taproot, accompanied by several large laterals and many smaller ones, underlies and supports a very short stem, crowned with a dense tuft of long, drooping, grasslike foliage. This period of apparently little activity is very deceptive and has been one cause of the general impression that longleaf is a very slow grower. Generally, from 3 to 5 years are required for longleaf to reach the height of 6 inches to a foot and develop the requisite root system for making the rapid "shoot" upward which follows. Under protection from fires, it is known that on loamy sand in the upper

Coastal Plain longleaf saplings at 5 years of age reach heights of 2 to 3 feet and at 7 years of 5 to 8 feet. The occurrence of fires at frequent intervals, usually of about 2 years, in different sections over practically the entire longleaf pine belt, and the accompanying marked effect in checking growth should not be overlooked in any consideration of the rate of growth.

Since the purpose here is chiefly to consider growth after the youngest or seedling stage, the germination of the seed and the early seedling development will be discussed under "Reforestation" in connection with getting young stands started.

The period of vigorous growth, during which the longleaf saplings "shoot" up rapidly, begins at an age of about 5 years and continues to about 20 to 25 years. At about 7 years, the height of saplings sometimes increases 3 to 4 feet during a single year. A growth of 2 feet a year in well-stocked stands is common over large areas (fig. 2 and Pl. V.), and open-grown trees on average good situations not uncommonly grow from 2 to 3 feet yearly. At the same time, the young trees grow to a diameter (at the ground) of about 2 inches during the 2 to 4 years following the early preparatory stage. Varying widely, longleaf saplings require 6 to 8 years on an average to reach breast height, or 4½ feet above the ground. After the maximum rate of height growth, at an age prior to 20 years, the rate gradually diminishes. It should, however, be clearly understood that young longleaf pine trees, subjected to hot fires, do not grow at the rates indicated. On protected old fields in the flatwoods of eastern North Carolina, measurements of longleaf pines show that in 35 to 50 years the average trees produce saw logs 14 to 20 inches at the butt and 20 feet in length.* The usefulness of these pine trees, however, would begin a little earlier if they were turpentined, and the thinning out of the foliage would also encourage the incoming of the tender grasses which are valuable for pasturage. This may be considered as about the average of the better growth to be expected throughout the longleaf pine region. The soil conditions on old fields are favorable, probably because of changes taking place in the hardpan layer.[1]

The most useful information regarding the rate of growth is obtained by measuring the amount of growth actually taking place in stands approximately even-aged and fairly well stocked. The trees in such stands grow tall, straight, and clean of branches, but relatively slow in diameter (Pl. IV). At any given age, therefore, the average trees in well-stocked stands will be considerably smaller

*By W. W. Ashe, formerly in charge of investigations, North Carolina Geological Survey.

[1] Studies by J. O. Veatch, Bureau of Soils, U. S. Department of Agriculture.

in diameter than those of similar age growing in the open. Likewise, at relatively early ages—at 30 years for example—an acre that was half stocked might have trees of saw-timber size, whereas a fully stocked stand might not have any trees of merchantable saw-timber sizes.

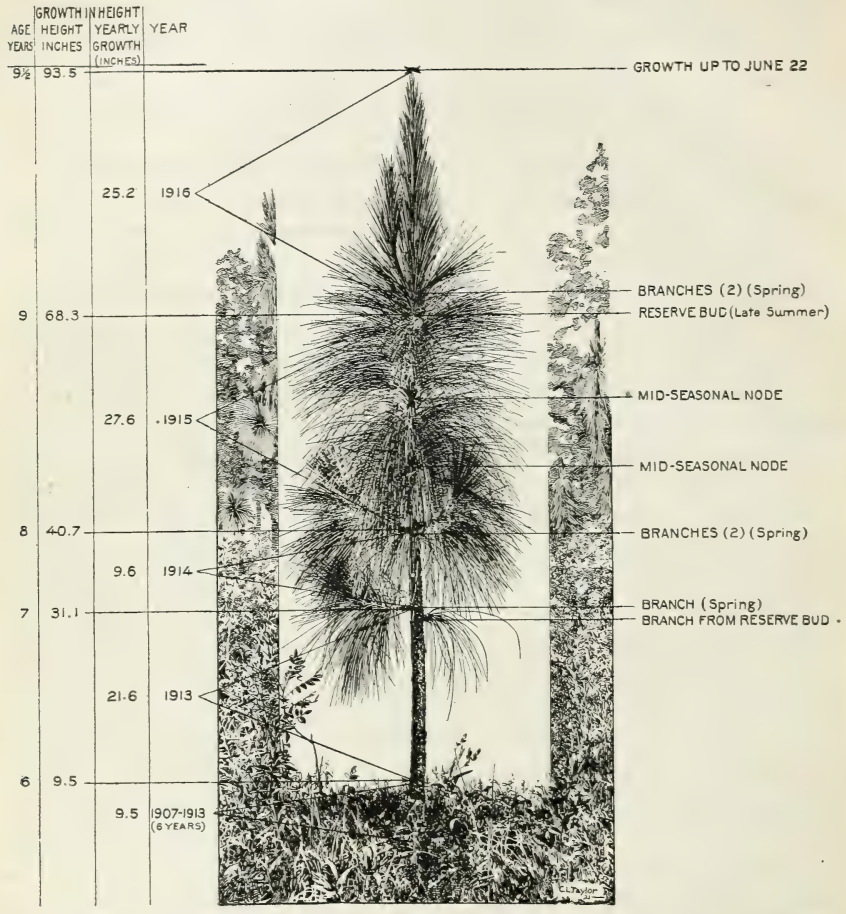


FIG. 2.—Natural growth of longleaf pine for the past 4 seasons under fire protection; nearly 8 feet tall in 9½ years. Photographed in June during period of rapid upward growth. (Jasper County, S. C.)

Table 1 shows, for different ages, the average height and diameter of longleaf pine trees growing in well-stocked, even-aged stands, on three different grades of land or situations. These figures, it is believed, are approximately representative of the rate of growth in stands of good density over the range of longleaf pine. They are based upon the measurement of selected portions of 78 longleaf pine stands whose locations range from South Carolina to Texas.

TABLE 1.—*Average growth of trees in height, diameter, and number of trees per acre in well-stocked, even-aged longleaf pine stands on various qualities of land.*

Age of stand.	Height.			Diameter[1] (breast high).			Approximate number of trees per acre.[2]
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	
Years.	*Feet.*	*Feet.*	*Feet.*	*Inches.*	*Inches.*	*Inches.*	
15	39	24	10	5.3	3.6	1.9	550
20	50	34	19	7.0	5.0	3.1	450
25	58	42	27	8.1	6.0	4.0	393
30	63	48	33	9.0	6.9	4.8	355
35	68	54	39	9.7	7.6	5.5	328
40	72	58	43	10.4	8.3	6.2	308
45	75	61	46	10.9	8.8	6.7	293
50	78	64	49	11.4	9.3	7.2	280
55	80	66	52	11.8	9.6	7.5	270
60	82	68	54	12.1	10.0	7.8	264
65	83	69	56	12.4	10.2	8.0	258
70	84	70	57	12.7	10.4	8.2	254

[1] Diameters measured at breast height, or 4½ feet above the ground.
[2] The number of trees per acre varies considerably with age, but for any given age averages approximately the same on the better and poorer classes of land. Not only can the better lands support more trees of a given size, but the trees are much larger in size at any specified age than on unfavorable situations

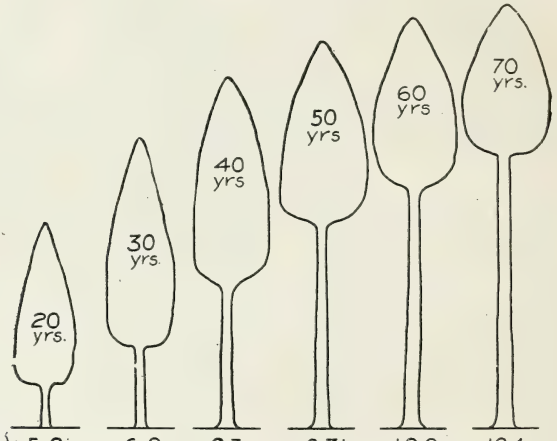
On good lands, or good situations, it will be seen, for example, that at 20 years longleaf pine reaches heights averaging about 50 feet; on medium land, about 34 feet; and on poor land, about 19 feet. The medium class of land, for instance, would include the loamy sands of the middle and upper Coastal Plains, and the last class the poorer parts of the flatwoods and the very deep, dry sands. The corresponding diameters, depending upon the situation, range from 7 inches down to a little over 3 inches. During the next 10 years, the trees increase yearly in height at the rate of about 1.4 feet (16.8 inches) and in diameter nearly 2 inches. The average diameter, as shown, usually represents an actual range of 4 to 6 inches, or 2 to 3 inches greater and 2 to 3 inches less. Likewise, the average height would probably represent a range of 5 feet at 20 years and as much as 10 feet at 50 years. The average diameter at breastheight, for example, of trees in a 25-year-old stand on a medium grade of soil is shown to be about 6 inches, and the trees in that particular stand probably ranged in diameter mostly from about 8 inches down to 4 inches. Table 1 shows that longleaf trees growing in well-stocked stands on medium situations (land), have an average yearly height growth of about 17 inches at 25 years, 12 inches at 35, 6 inches at 50, and 4 inches at 60 years; and an increase in diameter at the rate of about 1 inch in 5 years at 25 years, in 7 years at 35, in 12 years at 50, and in 16 years at the age of 60 (fig.3).

There should be no misapprehension regarding the time necessary to grow a crop of pines to a size that is merchantable for timber or turpentine, or about the close relation existing between the number

of trees per acre (tree density) and the rate of growth of the trees in the stand. The number of longleaf trees per acre for well-stocked stands does not seem to be widely variable at any given age for the different classes of situations, and those shown in Table 1 represent for the various ages about the average for all classes of land. The numbers of trees shown for successive ages indicate how tree population gradually decreases, because the more vigorous ones crowd out the others which are unable to keep up in the competition for light and root space.

GROWTH ON CUT-OVER LAND.

Trees of longleaf pine left in logging on the better classes of soils usually show an accelerated rate of growth, sometimes to a very



	20 yrs.	30 yrs.	40 yrs	50 yrs	60 yrs	70 yrs.
Average Diameter (At 4½ Ft.)	5.0 in.	6.9 in.	8.3 in.	9.3 in.	10.0 in.	10.4 in.
" Height	34 ft.	48 ft.	58 ft.	64 ft.	68 ft.	70 ft.
" Volume (Ft. B.M.)	10	25	40	70		80
" Yield per Acre (Ft B.M.)	1,500	6,000	10,500	14,500		18,000

FIG. 3.—Growth and yield of longleaf pine on medium soil.

marked extent. On thin, poor, poorly drained soils, and on very deep, dry, sandy soils an absence of stimulated growth following logging has generally been reported.

In central Louisiana (Winn and La Salle Parishes) accelerated growth in diameters as high as 200 to 300 per cent has been found. Trees, for example, that measured 10 inches in diameter at the time of logging and had grown only 1.6 inches during the preceding 10 years, at the end of 10 years after logging had increased 3 inches in diameter. This represents an actual increase in timber volume of about 200 per cent, or a final volume of three times the former size—a rate which held generally true for trees up to 15 inches in diameter, but fell off considerably for larger trees. With the increase both in size and stumpage value in the 10 years the value of the 15-inch tree went from 23 cents to 72 cents, while the 10-inch tree increased its former value six times.

Another example may be cited. On a tract logged "clean" in 1903, about eight trees per acre were left as culls. They were spike-topped, crooked, and suppressed in growth, and averaged about 8 inches in diameter breast high. Within 2 years these trees had started a rapid growth and for the next 12 years increased at the rate of 1 inch in every 4 years. The average diameter in 1917 was 12 inches. At the time the trees were left they contained 226 board feet per acre and in 1917 a total of 803 board feet per acre, or three and one-half times their former volume—a gain of 250 per cent in less than 15 years. At $5 per thousand feet, 800 board feet would bring $4, a sum sufficient to cover, for the entire period of 15 years, the cost of fire protection at 10 cents per year, reckoned at 5 per cent compound interest, and give a return of 5 per cent compounded on an assessed land value of $2 per acre. Table 2 shows the growth which actually took place on the cull trees during a period of 15 years following logging.

TABLE 2.—*Actual growth in volume of cull longleaf pine trees, left in logging, during the 15 years subsequent to lumbering; on loamy sand in the interior coastal plain of central Louisiana.*[1]

Diameter of trees (breast height) 1902.	Volume of trees (Scribner rule).		Growth in 15 years (1902 to 1917).	
	1902	1917	Volume.	Per cent (based on volume in 1902).
Inches.	*Board feet.*	*Board feet.*	*Board feet.*	*Per cent*
7	10	80	70	700
8	20	95	75	375
9	32	104	82	256
10	45	134	89	197
11	62	157	95	153
12	83	186	103	124
13	110	223	113	103
14	142	264	122	86
15	185	315	130	70
16	235	371	136	58
17	300	445	145	48
18	375	528	153	41

[1] Measurements by W. W. Ashe, U. S. Forest Service.

GROWTH UNDER FIRE PROTECTION.

Under repeated burning, growth is continually set back and finally most of the saplings are killed. This has, for many years, been occurring over practically the entire South (Pl. VI). The yearly height growth of longleaf-pine saplings from 4 to 12 feet in height (mostly 6 to 8 feet) was ascertained simultaneously on a tract burned over yearly, and on an adjacent tract which, after having been protected for five years, was accidentally burned in February, 1917, and afterwards protected. The average yearly growth in height of 100 saplings, on each of the tracts during a period of

two seasons before and two after the burnings, furnishes good evidence of the effect of protection. (See Table 3.)

Because of the stimulus of increased light and soil moisture, a tree measuring 10.4 inches in diameter at the time of logging grew during the next 18 years to a diameter of 18.2 inches, an average of nearly 1 inch in 2 years. The merchantable length increased from 48 to 56 feet; the merchantable volume from 100 to 326 board feet, an average yearly increase of 13 per cent and a total increase of 226 per cent. The butt log, which at the time of logging would have furnished a 4 by 4 stick, now yielded a 10 by 10 timber. The value of the standing tree at $1 per thousand was 10 cents when it was left in logging, and in 1920 at $8 per thousand it was $2.60. The value of the lumber product of the tree increased from $1.70 to $14.75.

TABLE 3.—*Growth in height of longleaf trees from 4 to 12 feet in height, on lands burned yearly and on protected lands. (Berkeley County, S. C.)*

Year.	Yearly growth in height.		
	On land burned over yearly.	On protected or "rough" land (except burned in February).	Growth on burned land on basis of that on unburned land.
	Inches.	*Inches.*	*Per cent.*
1915	11.8	19.6	60
1916	12.9	22.1	58
1917 [1]	15.0	10.2	147
1918	12.3	18.1	68
Total [2]	52.0	70.0	[3] 74

[1] Fire in February. [2] Four years. [3] Average.

Thus the two-year average growth of longleaf pine for 1915 and 1916, on the land regularly burned over, was 12.4 inches as compared with 20.3 inches on the unburned land, or a growth on the burned land of only 61 per cent of normal.

Following the accidental fire on the protected land, the growth the following season averaged only 10.2 inches, or about one-half the usual amount under protection; and the following or second

FIG. 1.—The growth of young pine is being observed and measured on the flat "crawfish" lands at the Coast Experiment Station (near Summerville, S. C.), a branch of the Clemson Agricultural College. The trees are numbered, and observations furnish accurate information upon which to base predictions of future growth and forest management. Special measures are taken to protect the land from fires.

FIG. 2.—Following closely behind logging, cull trees, short butts, tops, and branches are being cut up into 5-foot lengths for pulpwood. This is good utilization. Along with this class of material, however, all small pole trees and saplings down to 4 inches in diameter unfortunately are being taken. Some pulpmills in the South are using little else besides second-growth sap pine—a practice that is ruinous to the future forests, and is coming to be realized as such. (Louisiana.)

FIG. 1.—Young longleaf pine, 2 feet in height, repeatedly stunted and finally killed to the ground by fires. It has sprouted at the base, but a short time before this picture was taken the sprouts were killed by fire. (Marion County, Fla.)

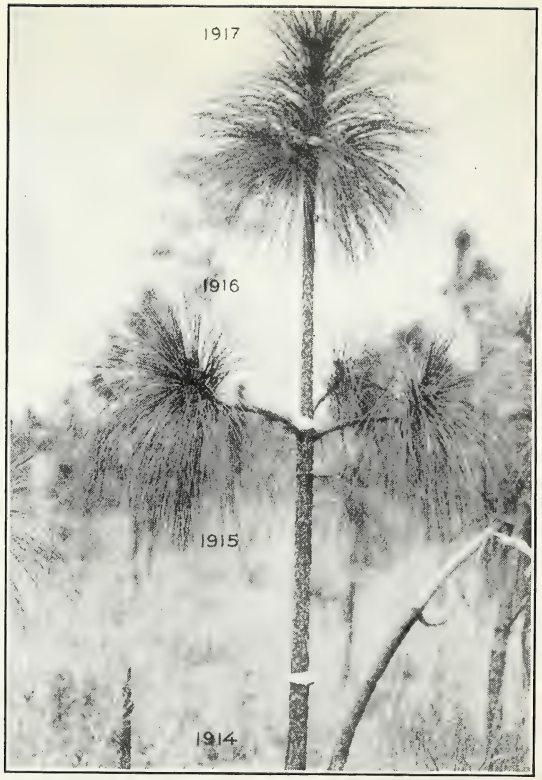


FIG. 2.—Under protection from fire, this longleaf pine grew 12 inches in 1914, 23 inches in 1915, and 28 inches in 1916. However, following a fire in February, 1917, it lost all of its leaves, and during the season had to depend merely upon the single new set of foliage shown, resulting in a growth of only 10 inches during the season. Ends of year's growths marked by strips of white cloth. (Photo taken in early spring of 1918, and the new growth for 1918 is seen in the elongated bud at tip above the leaves.)

season after the fire the growth averaged 18.1 inches, still a little below the general average.

PRODUCTION OF TIMBER.

Second-growth longleaf pine is increasingly used for lumber, crossties (to be treated), cooperage, boxes, crates, pulp wood, mining timber, and fuel wood. Similar new uses for small-sized timber with wide rings and coarse texture have been successfully found in all the older timber-producing sections of the country.

MEASUREMENTS of adjacent young longleaf stands, one burned and the other unburned for a period of five years, showed an average yearly growth under protection of 18.4 inches, but of only 5.8 inches when burned over every year.

A tract of young longleaf saplings, under observation at Urania, La., after being burned over yearly for five years, contained longleaf saplings mostly up to 1 foot and none over 2.8 feet in height, while in a similar tract protected against fires one-sixth of the trees were over 2 feet and others ranged up to 7 feet in height. The two tracts originally contained approximately the same number of longleaf seedlings and both had been continuously protected against hogs.

The wood of longleaf pine is classed as heavy, hard, and strong. It has been for many years the standard of the southern yellow pines, and by far the leading wood of all southern species in point of amount of production and total value. This applies, of course, mainly to old-growth timber. Second-growth longleaf timber has wider annual rings and contains a higher percentage of sapwood.

The amounts of various products referred to in the following tables and discussion are based upon measurements of sample areas selected as being representative of the best or ideal condition in respect to the density or number of trees per acre. Such well-stocked stands have enough trees so that all the available space and soil moisture are fully utilized. *Fully stocked stands do not occur continuously over large areas, but are confined generally to tracts containing at most only a few acres, such as old fields or the paths of tropical hurricanes. The*

figures of amounts per acre are consequently much higher than those that would result from the cutting of ordinary stands. In the use of such ideal tables there is always great danger of overestimating the amount of timber that is produced and may be cut from average stands as they are commonly found.

CROSSTIES AND CORDWOOD PRODUCTION.

The approximate numbers of crossties and cords of wood (with the bark and without the bark) produced in well-stocked stands at different ages are shown in Table 4. These figures should be considered as only approximate, since various factors enter in to determine the rate of growth and production of merchantable timber. Three qualities of situation are shown under the headings of good, average, and poor land. The yields are based upon the number and sizes of trees as counted and measured in stands and upon the computed number of ties and cords that can be cut from trees of different sizes; the figures do not represent amounts actually cut.

The information contained in Tables 5 and 6 will be found useful in calculating the numbers and grades of ties that can be obtained from trees of different sizes. The sizes of the standard grades of ties are: No. 1, 6 by 6 inches; No. 2, 6 by 7 inches; No. 3, 6 by 8 inches; No. 4, 7 by 8 inches; No. 5, 7 by 9 inches. The standard lengths are 8 and 8½ feet. Table 6 shows the number of ties by grades that can be cut from trees of different sizes, no allowance being made for defects. For example, trees measuring 15 inches in diameter at breast height and 60 feet in height will, on the average, cut out three grade No. 2 ties, one grade No. 4 tie, and one grade No. 5 tie. Table 5 gives the total number of ties without specifying the grades. Copies of specifications for ties may be secured from the local railroad agent or can be found in Farmers' Bulletin 1210, Measuring and Marketing Farm Timber.

TABLE 4.—*Crossties and cordwood (pulpwood or fuelwood) produced per acre by well-stocked, even-aged stands of longleaf pine at different ages. (Approximate.)*

Age of stand.	Crossties (No. 3, 6 in. by 8 in. by 8 ft.).			Cordwood.					
				Wood with bark (fuel wood, etc.).			Peeled wood (pulp wood, etc.).		
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.
Years.	*Ties.*	*Ties.*	*Ties.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*	*Cords.*
20	.....	.....	.....	24	14	3	19	10	2
30	230	30	.....	49	29	8	39	21	6
40	440	245	50	61	39	17	51	31	13
50	610	385	160	70	48	26	59	39	20
60	750	510	270	78	55	33	66	45	26
70	870	620	370	84	62	40	72	51	31

TABLE 5.—*Number of crossties that can be cut from longleaf pine trees of different diameters and heights.*

[For detailed information by grades of ties, see Table 4.]

Diameter of tree.[1]	Height of tree in feet.						
	40	50	60	70	80	90	100
	Total number of ties per tree.						
Inches.							
10	.....	.....	1	1	2	.....	.....
11	1	2	2	2	[2]4	.....	.....
12	2	2	3	3	[2]5	5	.....
13	.....	.....	3	4	[2]6	6	.....
14	.....	.....	4	5	[2]6	7	8
15	.....	.....	5	6	[2]6	7	8
16	.....	.....	5	6	8	9	10
17	.....	.....	.....	8	9	10	12
18	.....	.....	.....	9	10	11	13
19	.....	.....	.....	10	11	12	14
20	.....	.....	.....	11	11	14	15

[1] All diameters measured at breastheight, or 4½ feet above the ground, and outside bark.
[2] See Table 4, which shows the way the ties were worked up into ties of different grades.

Large amounts of longleaf pine are used for pulpwood by the pulp and paper plants located in the range of the species (Pl. V). Such plants are located at Roanoke Rapids, N. C., Savannah, Ga., Bogalusa, La., Moss Point, Miss., and Orange, Tex. The sulphate process of manufacture is used, and a standard cord of air-dry longleaf pine, containing about 100 cubic feet of solid wood and weighing about 4,200 pounds when air-dry, will produce about 1,600 pounds of dry pulp. The "green" weight of wood as ordinarily handled is variable, depending upon the weather and the time elapsed since the felling of the tree. The southern pine region offers a promising field for the future development of the paper business, particularly for the grade of "kraft," or heavy wrapping paper, for which the wood of the yellow pines is well adapted. Recent tests, however, made at the Forest Products Laboratory have shown the possibility, if proper cooking and bleaching processes are employed, of using the southern pines for the production of high-grade book and magazine paper. This kind of paper requires a long-fibered wood, such as that of the pines, and a short-fibered wood, such as that of the red gum. Crossties from farm timber lands constitute a product of much commercial value. Slack time during the cool season may often be profitably employed in getting out ties. In the winter of 1920–21 the cutting of crossties practically effected the financial salvation of many farmers in various portions of the South. Sap-pine ties, when treated, show good lasting qualities and are being used more and more as heart pine becomes scarcer and more valuable. As young timber grows, it requires more space for proper development, and the thinnings (see under "Cutting") required in well-stocked stands, at intervals of very 5 to 10 years, may often be made to yield good money in crossties or pulpwood.

SAW-TIMBER PRODUCTON.

Information regarding the approximate amount of saw timber contained in individual trees of different sizes is sometimes wanted. The amounts shown in Table 7 are based upon the measurement of 438 longleaf pine trees in central Alabama, taking the logs above a 1-foot stump and down to a top diameter of 6 inches. Table 8 shows the amount of lumber in logs from different parts of turpentined and unturpentined trees.

TABLE 6.—*Number of crossties by grades that can be cut from longleaf pine trees of different diameters and heights.*[a]

Diameter of tree (breast high) outside bark.	Height of tree in feet.						
	40	50	60	70	80	90	100
Inches.							
10	.....	.....	1^1	1^1	2^1	.....	.....
11	1^2	1^1 1^2	1^1 1^2	1^1 1^2	2^1 2^2	.....	.....
12	1^2 1^3	1^1 1^3	1^1 1^2 1^3	1^1 1^2 1^3	1^1 2^2 1^3 1^4	2^1 1^2 1^3 1^4	.....
13	.....	.....	1^2 1^3 1^4	1^1 2^3 1^4	1^1 1^2 2^3 1^4 1^5	1^1 1^2 2^3 1^4 1^5	.....
14	.....	.....	1^1 1^3 1^4 1^5	1^1 1^3 1^4 2^5	1^1 1^3 2^4 2^5	1^1 1^2 1^3 1^4 3^5	2^1 2^3 1^4 3^5
15	.....	.....	3^2 1^4 1^5	1^1 1^2 1^4 3^5	1^2 1^3 4^5	1^1 1^3 1^4 4^5	1^1 1^2 1^3 1^4 4^5
16	.....	.....	3^3 2^5	1^1 1^3 4^5	1^1 2^2 1^3 1^4 3^5	1^1 3^2 1^4 4^5	1^1 3^2 1^3 1^4 4^5
17	.....	.....	.....	3^2 2^3 1^4 2^5	1^1 2^2 3^3 3^5	1^1 2^2 3^3 4^5	5^2 3^3 1^4 3^5
18	.....	.....	.....	2^2 5^3 2^5	3^2 4^3 1^4 2^5	1^2 6^3 1^4 3^5	3^2 6^3 1^4 3^5
19	.....	.....	.....	2^2 4^3 3^4 1^5	2^2 5^3 4^5	7^3 5^5	2^2 7^3 1^4 4^5
20	.....	.....	.....	1^1 4^3 2^4 4^5	5^3 2^4 4^5	7^3 1^4 6^5	2^2 5^3 2^4 6^5

[a] The grade is indicated by the smaller numeral shown above and to the right of the numeral giving the number of crossties of the specified grade. For example: 1^2 means one No. 2 crosstie. The scale is for straight and sound trees, no allowance being made for defect.

TABLE 7.—*Contents in board feet of longleaf pine trees of different diameters and merchantable lengths.*

[Stump height, 1 foot. Diameter (inside bark) of top, 6 inches. Scaled by Scribner Decimal C rule.]

Diameter of tree, breast high.	Number of 16-foot logs in tree.										
	1	1½	2	2½	3	3½	4	4½	5	5½	6
	Volume—Board feet.										
Inches.											
8	16	31	46	.....	.....	.....	.....	.....	.....	.....	.....
9	17	32	47	62	.....	.....	.....	.....	.....	.....	.....
10	18	34	50	67	84	.....	.....	.....	.....	.....	.....
11	20	37	54	74	94	110	.....	.....	.....	.....	.....
12	21	41	60	83	110	130	160	.....	.....	.....	.....
13	22	46	67	95	120	150	180	210	.....	.....	.....
14	24	52	77	110	140	170	200	230	250	.....	.....
15	.....	58	90	130	160	200	230	260	290	320	.....
16	.....	64	100	140	180	220	260	300	330	370	400
17	.....	.....	110	150	200	250	290	340	370	410	450
18	.....	.....	120	170	230	280	330	380	420	460	500
19	.....	.....	140	190	250	310	360	420	470	520	560
20	.....	.....	150	210	280	340	400	470	530	580	630
21	.....	.....	.....	230	300	380	450	520	590	650	710
22	.....	.....	.....	250	330	410	490	570	650	720	790
23	.....	.....	.....	270	360	450	540	630	720	800	870
24	.....	.....	.....	290	390	490	590	690	790	880	960

TABLE 8.—*Amount of lumber actually sawed out of 16-foot longleaf pine logs of different sizes in band sawmill (Louisiana) and comparison with the Doyle-Scribner scale.*

Top diameter of log.	Butt logs.		Logs (taken above the butt cut).[1]		Doyle rule.
	Unturpentined.	Turpentined (boxing), 4 years.	Rough logs.	Smooth logs.[2]	
	Board feet.				
Inches.					
6	18	.....	20	16	4
7	27	.....	29	24	9
8	38	32	41	34	16
9	51	42	55	47	25
10	65	53	72	62	36
11	81	67	90	79	49
12	99	81	110	98	64
13	118	96	132	120	81
14	139	114	156	145	100
15	163	131	182	172	121
16	189	151	210	202	144
17	216	.....	240	234	169
18	245	.....	270	267	196
19	275	.....	306	304	225
20	308	.....	.....	344	256
21	342	.....	.....	387	289
22	377	.....	.....	432	324

[1] The greater cut above the butt logs is accounted for by the fact that there was less defect.
[2] The smaller cut than that shown under the heading "rough" logs is due to an increased product in the form of laths, etc.

In considering the amount of saw timber per acre yielded by longleaf pine, it should be borne in mind that the species belongs essentially to the poorer classes of land, large parts of which are either flat and poorly drained or dry and very sandy. In comparison, both slash and loblolly pines occupy the more fertile, loamy, and humus soil. The figures of saw-timber yields refer to what would commonly be considered as very dense stands, which produce long, clear trunks, yielding clear, high-grade material, but of relatively small diameters for specified ages (Pl. I). Had there been a considerably smaller number of trees per acre than that shown in Table 1, the trees would earlier have reached merchantable saw-timber sizes, and, therefore, would have shown larger amounts per acre, at the ages, say, of 30 to 50 years. Denser stands, however, although slower in growth, give at a little later age a higher total production of timber.

Table 9 shows for different ages of stand and various kinds of land the approximate total yield of saw timber per acre. The market is accepting yellow pine lumber of poorer grades. This change has been rapid since the rise of the extra demand for lumber in about 1917. As a result, information regarding the actual cut of lumber per acre from young stands is frequently desired. The amount shown under the heading of "mill scale" is that which can

be sawed out by using the tree above a 1-foot stump and down to a top diameter of 4.6 inches. It is the form of utilization now general in parts of New England. Another column shows the amount of lumber yielded per acre according to the Doyle log rule—which is in common use in the South—and the difference is striking. Tabulated information of this kind will be found useful in predicting the amount of growth that may be expected to take place during a specified period—5 years or multiples thereof—upon different qualities of situation or classes of land. On medium land, for example, well-stocked longleaf stands at 40 years of age have been found containing an average of 6,200 board feet, and these may be expected to grow 4,200 board feet during the next 10 years, at which time they will contain a total of about 10,400 feet. On good land, or favorable situations, measured 40-year-old stands, well stocked with trees, have contained an average of about 11,000 board feet, increasing during the next 10 years by about 5,200 board feet, to a total of 16,200 feet at 50 years of age. The caution is here repeated that these are fully stocked stands and very much better than the average (Pl. VII). The degree of stocking, or the amount of unused space in the stand, should be taken fully into account in estimating any piece of timber.

TABLE 9.—*Amount of saw timber in board feet grown in longleaf pine stands that are even aged and well stocked with trees.*

Age of stand.	Mill scale, or actual cut.						Doyle rule.		
	Trees 10 inches and over in diameter.			Trees 8 inches and over in diameter.			Trees 7 inches and over in diameter.		
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.
Years.									
30	5,900	1,200	.....	10,800	5,700	700	3,500	1,900	300
35	8,500	3,800	.....	14,200	8,200	2,200	4,800	2,900	1,000
40	11,000	6,200	1,500	17,100	10,400	3,800	6,200	4,000	1,700
45	13,600	8,400	3,100	19,600	12,600	5,300	7,600	5,000	2,500
50	16,200	10,400	4,600	21,800	14,400	6,900	9,000	6,100	3,200
55	18,800	12,400	6,100	23,700	16,000	8,200	10,300	7,200	4,000
60	21,400	14,400	7,500	25,300	17,400	9,500	11,600	8,200	4,700
65	23,700	16,200	8,800	26,900	18,800	10,700	12,900	9,200	5,500
70	25,800	17,900	10,000	28,900	20,200	11,900	14,200	10,200	6,200

The final yields here shown, it should be noted, are the full contents of the stand at the assigned ages and do not include timber that may have been produced previously, or the intermediate yield, often a very considerable amount. This is the product of any thinnings that may have been made (see under "Cutting") and of the timber that has died out during the life of the stand. With advance in the age and size of the trees there comes a natural reduction in the number of trees by the weaker giving way. The process may

be observed in any well-stocked stand in which are found dominant trees, others that are barely living, and still others that have died for lack of overhead light, soil moisture, or root space. If these trees are cut and utilized, the total yield of the stand is considerably increased, and the stand is made more profitable.

The following facts concerning a few of the stands actually measured (see Table 10) will serve as illustrations of what may be expected in the way of yields from well-stocked longleaf stands, commonly considered locally as "dense" stands:

1. A 23-year-old stand, consisting of 210 trees per acre averaging 8.1 inches in diameter and 76 feet in height, contained 23 cords of wood (with the bark) or 17 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 2,850 board feet; or if all trees 8 inches and over were cut, it would produce 4,984 feet. By the Doyle log rule, however, all trees measuring 7 inches and over in diameter scaled only 1,430, or less than one-third of what might actually be sawed.[2]

2. A 25-year-old stand, with 560 trees per acre averaging 29 feet in height and 4.2 inches in diameter, contained 10 cords of wood with the bark on or 7 cords of peeled wood. The stand had no trees as large as 10 inches in diameter, but contained about 700 board feet of timber in trees 8 inches and over in diameter. If the logs in the trees measuring 7 inches and over were scaled by the Doyle rule, there would be only 160 board feet per acre.

3. A 25-year-old stand, containing 279 trees which averaged 54 feet in height and 7.6 inches in diameter, contained 30 cords with bark, or 23 cords of peeled wood. It amounted to 3,579 feet, if it was closely sawed, and if all trees 10 inches and over were used; or 6,980 feet if all the trees down to and including those 8 inches in diameter were taken. If scaled by the Doyle rule, the stand had 2,157 feet.

4. A 50-year-old stand, which consisted of 304 dominant trees averaging 63 feet in height and 9.2 inches in diameter, contained 55 cords of wood with bark, or 42 cords without bark. It had 8,565 board feet if closely utilized down to and including 10-inch trees, or 14,450 feet if the trees 8 inches in diameter and larger were used. The Doyle rule gave 2,128 board feet.

5. A 70-year-old stand—an average of two stands of the same age (Pl. I)—consisted of 265 trees per acre which averaged 68 feet in height and 11.2 inches in diameter, and contained 58 cords of wood with bark or 46 cords without bark. If scaled by the Doyle rule, all trees 7 inches and up showed 9,600 board feet. If cut closely and actually scaled or measured at the mill, all trees 10 inches and up contained about 18,000 board feet, or all trees 8 inches and up (there were only a few of this class) contained 19,400 board feet.

If the above-described stands are examined, and if reference is made to Tables 1, 4, and 9, it will be noted, for example, that the 23-year-old stand (1) consisted of relatively few trees per acre, but that these averaged large both in diameter and in height. Also, as com-

[2] By the Doyle rule, small-sized timber usually scales only one-third to two-thirds of the amount that can actually be cut by careful sawing and close utilization in the log.

TABLE 10.—*Longleaf pine—Actual measurements of 32 well-stocked second-growth stands, from 8 to 100 years old, showing average sizes of trees, number of trees, and yields per acre, based on selected portions of 78 well-stocked stands from South Carolina to Texas.*

Age.	Trees per acre.		Average height.		Average breast-high diameter.		Total basal area.		Yield per acre.						
									Solid measure.[1]		Saw timber.				
													Mill scale.[5]		
	Dominant trees.	Total.	Dominant trees.	All trees.	Dominant trees.	All trees.	Dominant trees.	All trees.	With bark.[2]	Without bark.[3]	Doyle scale.[4]	Scribner scale.[4]	Trees 5 inches and over.	Trees 8 inches and over.	Trees 10 inches and over.
Years.	*Number.*	*Number.*	*Feet.*	*Feet.*	*Inches.*	*Inches.*	*Sq.ft.*	*Sq.ft.*	*Cords.*	*Cords.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*
10–12	1,610	1,610	12	12	2.2	2.2	44	44	3.1	1.9	.....	.....	80	.....	.....
10–15	.....	768	.....	.....	.....	3.3	.....	49	.....	.....	.....	.....	.....	.....	.....
12–17	1,040	1,690	25	20	3.4	2.8	64	72	10.5	7.0	.....	.....	1,140	.....	.....
15–17	.....	292	.....	44	.....	7.0	.....	78	.....	.....	500	2,459	4,778	2,361	.....
18	1,310	1,310	23	23	3.2	3.2	75	75	11.7	7.9	20	180	1,520	140	.....
20	.....	640	.....	36	.....	5.7	.....	114	24.0	17.0	96	1,088	5,376	576	.....
22	.....	448	.....	44	.....	6.5	.....	128	27.0	20.0	768	3,856	6,400	2,992	704
23	.....	210	.....	53	.....	8.1	.....	76	23.0	17.0	1,430	4,890	6,310	4,984	2,850
24	.....	304	.....	53	.....	7.9	.....	104	43.0	24.0	1,720	6,792	8,488	6,720	2,968
24	.....	216	.....	48	.....	7.7	.....	68	19.0	14.0	1,149	3,546	4,971	3,618	1,827
25	.....	560	.....	29	.....	4.2	.....	54	10.0	7.0	160	640	1,760	704	.....
25	.....	279	.....	54	.....	7.6	.....	90	30.0	23.0	2,157	6,804	8,427	6,981	3,579
28	192	192	31	31	4.3	4.3	20	20	3.8	2.6	22	120	656	68	68
30	410	770	43	38	6.0	4.5	79	94	22.0	15.5	380	1,650	4,640	1,320	440
30	.....	330	.....	44	.....	6.9	.....	87	22.0	16.0	1,050	3,580	5,675	3,475	1,705
33	.....	303	.....	54	.....	7.7	.....	97	31.0	23.0	1,611	6,399	8,373	6,489	2,358
35	.....	188	.....	58	.....	8.6	.....	74	26.0	19.0	2,036	6,296	7,492	6,884	4,020
39	164	268	58	51	7.7	6.5	53	63	20.0	14.0	1,260	3,656	5,184	3,492	1,184
39	148	208	62	56	8.7	7.7	61	68	23.8	17.9	2,128	5,524	6,772	5,848	2,732
40	62	100	67	61	10.8	9.1	39	45	17.1	13.2	2,314	4,738	5,507	5,090	4,590
40	342	619	52	45	7.4	5.9	102	120	34.9	25.6	1,987	6,000	8,868	5,895	2,553
40	260	380	74	70	9.7	8.4	133	148	61.5	46.9	7,360	16,190	18,930	17,510	11,990
44	400	680	64	59	8.0	6.8	139	173	60.9	45.2	4,400	11,240	16,480	8,560	4,800
43–48	290	400	62	60	9.2	8.5	134	155	56.4	42.7	5,500	13,560	16,630	14,360	7,650
48	164	240	71	64	10.2	9.0	95	104	43.3	33.5	6,172	12,380	14,064	13,124	10,160

FIG. 1.—The owner values this old field longleaf pine highly. The trees are mostly 20 to 25 years old, and from 30 to 50 feet in height and 8 to 10 inches in diameter breasthigh—a very rapid growth. It is close to his house and furnishes the farm with poles, fuelwood, and recently small saw timber. Twice a year the pine straw is raked off and in part used for fertilizer on the cotton fields and partly sold in turn for stable bedding, as is extensively done in many parts of the South. A section of one is shown in Figure 2. The stand is very irregular and contains only about one-half the full number of trees. (Florence County, S. C.)

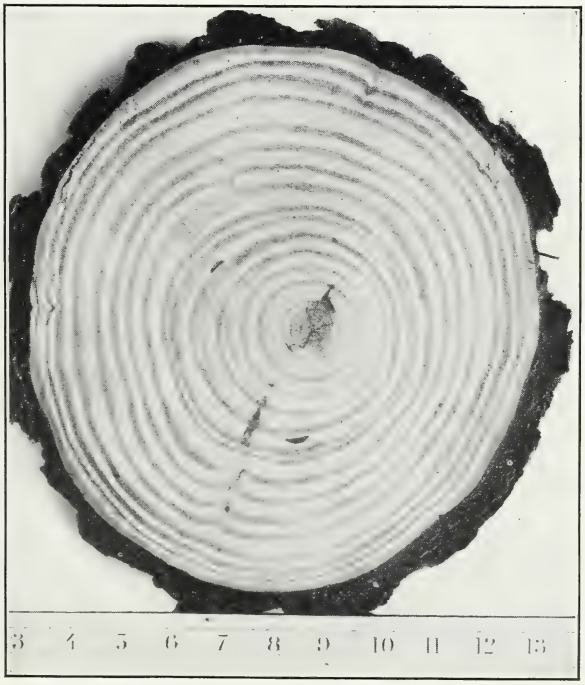


FIG. 2.—Section of representative tree in old field longleaf stand shown in Fig. 1. Twenty to twenty-four year old trees are 50 feet tall and 7 to 10 inches in diameter at breastheight. The section, cut at breastheight, shows 16 annual rings. The effect upon growth of a bad fire 9 years ago will be observed in the ninth ring counting from the outside. (Florence County, S. C.)

Chipping at about the midseason of the second year's working. This represents average good practice, but a single piece of iron is being much used instead of two bent gutters. At the rate of one-half inch at each streak, the face moves up the trunk about 16 inches a year. Including the high face, this permits of 6 to 8 years' working.

50–55	304	376	63	62	9.2	8.6	142	152	55.1	41.8	5,348	13,754	16,000	14,449	8,565
50–55	338	456	64	62	9.6	8.9	170	196	71.4	54.4	7,367	18,235	21,059	19,176	10,676
55		146		74		10.9		95	37.0	30.0	6,265	11,570	12,905	12,542	11,819
65–70	104	145	76	69	11.2	10.0	72	80	34.1	26.7	5,898	10,611	11,863	11,365	10,540
65–70	246	386	77	67	11.3	9.6	171	194	82.5	64.4	13,491	25,491	28,211	27,421	25,632
72	198	278	89	86	11.5	10.6	143	170	84.9	66.5	15,102	27,778	30,136	29,196	26,388
100		94		85		15.0		115	55.0	45.0	14,590	20,078	21,636	21,636	21,526

[1] All trees 3 inches and over in diameter breast high.
[2] Merchantable volume, including bark.
[3] Merchantable volume, stump height 1 foot, top diameter inside bark 1.5 inches.
[4] All trees 7 inches and over in diameter breast high; stump height 1 foot, top diameter inside bark 5.5 inches.
[5] Five and six inch trees scaled as if cut into flitch, to a top diameter inside bark of 3.5 inches. All other scaled to a top diameter inside bark of 4.5 inches, stump height 1 foot

pared with stands of that age, it contained about the average amount of cordwood but double the average amount of saw-timber. The two 25-year-old stands afford an interesting comparison, showing the effect of the tree density, or number of trees per acre. It will be noted that the first stand (2) contained over twice as many trees per acre as the second (3), and that, as a result, they are very much smaller—29 feet in height as compared with 54 feet, and 4.2 inches in diameter as compared with 7.6 inches, about one-third as much cordwood, and only 700 board feet as compared with 6,980 feet of saw-timber. The two 70-year-old stands (5) show very nearly the general average size of trees both in diameter and in height, and slightly less than the average amount of cordwood and saw-timber.

PRODUCTION OF TURPENTINE AND ROSIN.

The bulk of the turpentine and rosin produced in this country has been obtained from longleaf pine.[3] The average yearly production for the 6 years ending in 1919 has been estimated to range between 23,000,000 and 25,000,000 gallons of spirits of turpentine and between 700,000,000 and 820,000,000 pounds of rosin. The center of production has changed, gradually following the timber supplies from the Carolinas to Florida. The industry is extensive in Florida and is developing in Louisiana. Second-growth pine now furnishes most of the yield from South Carolina and Georgia, and smaller amounts from Florida and Alabama.

YIELD OF SECOND-GROWTH STANDS.

Young longleaf pine has been for many years worked for turpentine, and this is often its greatest and sometimes its only value. In this respect extensive abuse of young pine has come to be very general. As long ago as 1900 a considerable amount of the turpentine produced in South Carolina and coastal Georgia was derived from young stands of longleaf and slash pine. Since the common practice has been to work young stands heavily, let them burn freely, and make very little further use of them, the destruction of young longleaf has taken place on an extensive scale. Obviously this in part explains the prevailing absence of second growth.

Only a few preliminary studies have thus far been made in the amount of naval stores produced by second-growth longleaf pine. There is much need for accurate information in regard to the amount of gum yielded by trees of different sizes and ages and by entire stands or various ages and tree densities.

Table 11 gives a rough approximation of the yields per crop and per acre of crude gum, turpentine, and rosin from the first year's

[3] The remainder has come from working slash pine, a close associate of longleaf. (See Farmers' Bulletin 1256, Slash Pine.)

working of second-growth, well-stocked longleaf pine stands. Caution is necessary, however, in using the table, since it should be regarded as based upon insufficient data to make it final, but it is probably the best of its kind available. It is not based upon actual yields from whole stands, but has been computed from two sets of independent measurements, one relating to the sizes and numbers of trees per acre of growing longleaf stands (Table 1), and the other relating to the flow of gum from a limited number of trees of specified sizes (see Table 12). On the basis of this information, secured by the Forest Service, U. S. Department of Agriculture, the table was compiled jointly by the State Department of Conservation, New Orleans, La., and the Forest Service. It is included here with the hope that it may be the means of stimulating the collection of further measurements and the acquisition of more complete information. The yield of gum per crop is exceedingly variable, as is well known among operators, depending upon the locality and region (extending from North Carolina to Texas), the season, class of labor, and indirectly the market conditions. Hence, any figures of yield should be used with discretion.

TABLE 11.—*Computed production of gum, turpentine, and rosin from well-stocked second-growth longleaf pine stands, of various ages (virgin, or first year's working).*[1]

Age of stand.	Production per crop.			Production of gum per cup.	Production per acre.		
	Gum.	Turpentine.[2]	Rosin.[2]		Gum.	Turpentine.[2]	Rosin.[2]
Years.	*Pounds.*	*Barrels (50 gals.).*	*Barrels (500 lbs.).*	*Pounds.*	*Pounds.*	*Gallons.*	*Barrels (500 lbs.).*
20	37,000	18.5	61	3.7	186	4.6	0.3
30	53,000	26.5	88	5.3	1,122	28.0	1.9
40	68,000	34.0	113	6.8	2,190	54.7	3.7
50	74,000	37.0	123	7.4	2,760	69.0	4.6

Trees per acre in stand (all sizes).	Trees cupped per acre (grouped by diameter sizes).[3]								Cups per acre.
	Diameter of trees—inches.							Total.	
	7	8	9	10	11	12	13		
450	50	.....	.....	.....	.....	.....	.....	50	50
355	70	90	50	.....	.....	.....	.....	210	210
308	38	43	50	[4] 5	45	.....	.....	241	321
280	33	35	40	[4] 65	56	25	15	250	371

[1] This table is computed from two different sets of measurements and is not based upon actual measured yields of whole stands. The working of small trees and young stands is not good practice except where trees are to be removed in thinnings or the land to be cleared for other uses.

[2] Production of turpentine and rosin calculated on the basis of 100 pounds of gum yielding 2½ gallons of turpentine (one-twentieth barrel) and 83 pounds of rosin (one-sixth of a 500-pound barrel).

[3] One cup hung on each tree measuring 7 to 9 inches, inclusive, in diameter; two cups hung on about one-half of the 10-inch trees and on all trees measuring 11 inches and over.

[4] In the 40-year-old stand, 35 of the total 65 trees were 2-cup trees; in the 50-year-old stand, 25 of the 45 trees; and in both cases the remainder of the 10-inch class of trees were hung with one cup each.

Table 11 assumes that well-stocked stands are heavily cupped with one cup to every tree measuring 7, 8, or 9 inches in diameter, one cup on about one-half of the 10-inch trees and two on the remainder, and two cups on all trees 11 inches and over. The figures are for the first year's working. At 30 years, for example, the average yield per crop (10,000 cups) is shown to be 53,000 pounds of gum, which makes in turn about 26.5 barrels of spirits of turpentine [4] and 88 barrels of rosin. This is obtained from 210 cups per acre, each yielding 5.3 pounds of gum during the season. This number of cups was hung on 210 trees out of a total stand of 355 trees per acre. At 40 years, a yield of 34 barrels of turpentine may be expected. The yield per acre at 30 years was 1,122 pounds of gum, producing about 28 gallons of turpentine and 1.9 barrels of rosin. These yields

The production of turpentine and rosin has shown a marked downward trend for some 15 years. This is due chiefly to the exhaustion of virgin timber. The very wasteful and destructive methods generally employed with both old timber and second growth have always meant a total production much below what would be possible under a more conservative system. If the rate of decrease continues, within the next decade or so the United States will lose its commanding position in the world's market and may in time be unable to supply its domestic requirements.

seem to be very fair in comparison with the average of about 40 barrels of spirits per crop yielded by the better class of mature stands under good working in the Gulf region, and an average for all timber of about 20 barrels per crop. The inclusion of small sizes of trees and very close cupping should not be taken as any recommendation for operating such young stands as a general practice. The figures are given as an indication of what might be expected in working thick stands of young timber before thinning or clearing up the land.

On the Florida National Forest the longleaf pine of all ages and sizes, 10 inches and over in diameter, in a certain contract yielded a virgin working of 96,000 pounds of gum per crop, which gave 48 barrels of spirits and 134 barrels of rosin. This was an average yield

[4] By a coincidence this is the same yield as shown by the 1910 United States census for the average crop in Georgia, where much of the production is from second-growth timber.

of 9.6 pounds per face, of which 8.3 pounds were dip and 1.3 pounds scrape. The timber as a rule is old and very slow growing, but was worked conservatively.

UNPROFITABLE TURPENTINE PRACTICES.[5]

Working small-sized trees.—The figures given in Table 12 refer to young longleaf pine timber in southern Georgia, and show the weight of gum in cups ready for the first dip after six streaks. The trees ranged from 7 to 12 inches in diameter (measured at breast height, or 4½ feet above the ground); each tree was hung with one cup and was being worked for the first year. The production for the season is computed on the assumption that there were six dippings.

TABLE 12.—*Yield of gum per cup in the first dip, and computed yield for the season from different-sized trees.*

Diameter of tree (breast high).	Yield of gum per cup.		
	Per dip (6 streaks).	Per streak.	Per season, 6 dippings (computed).
Inches.	*Ounces.*	*Ounces.*	*Pounds.*
[1] 7	10.0	1.7	3.7
[1] 8	15.0	2.5	5.7
[1] 9	19.0	3.2	7.1
[1] 10	22.5	3.7	8.5
[1] 11	23.0	3.8	8.7
[1] 12	24.0	4.0	9.0
[2] 10	36.0	6.0	13.5
[2] 11	43.0	7.1	16.1
[2] 12	48.0	8.0	18.0

[1] One-cup trees. [2] Two-cup trees.

The most noteworthy point here is that a 7-inch tree yields less than one-half the gum yielded by a 10-inch tree. Of the 10-inch trees those with two cups yielded 60 per cent more gum than those having only one cup; of the 11-inch trees, they yielded 87 per cent more; and of the 12-inch trees, they yielded 100 per cent more. In operations on small timber the expense of cups, hanging, chipping, and dipping is incurred in connection with many trees that yield only about a quart of gum for a full season's working. Even smaller returns than those shown above are not uncommon. In May, 1920, third-year workings of these small sizes were found that yielded at the rate of 1 ounce of gum to each four streaks. The conclusion arrived at from these weighings is that, in general, timber less than 9 inches in

[5] The discussion is based upon studies and recommendations by Austin Cary, Logging Engineer of the Forest Service. See also "New Method of Turpentine Orcharding," Forest Service Bulletin 40. For sale by Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 10 cents.

diameter at breastheight, or about 10 inches on the stump, yields gum in such small amounts as to be considered below a workable size.

Faces per tree.—Observations on virgin crops indicate that the addition of the second face, when conservatively made and worked on longleaf pine trees from 10 to 12 inches in diameter at breast-height, increases the yield of the tree by about 70 per cent over the yield of one face. However, when trees under 12 to 14 inches in diameter have been worked with a second face their growth has nearly stopped. They have often been found to be in a sickly or dying condition. The more observing and practical operators feel justified for that reason in not permitting a second face on trees less than 15 inches in diameter; but, if a second face is allowed, they require that bars shall measure at least 4 inches across and that at least 40 per cent of the surface or circumference of the tree shall remain uncut.

Heavy chipping.—For conclusive results regarding the effect of heavy and light chipping, reference may be made to the experiments carried on in Florida by Dr. Charles F. Herty and published by the Forest Service[6] (Pl. VIII). To this may be added some results obtained by the Forest Service on the Florida National Forest near Pensacola. In these workings the trees were conservatively cupped, and chipping was limited to one-half inch in depth and the same in height. Under these conditions the results per crop of 10,000 cups from five successive years' work on a specified body of timber have been as follows: First year, 46 barrels; second year, 40 barrels; third year, 41 barrels; fourth year, 38 barrels; fifth year, 41 barrels.

The average season's production of gum per crop was, therefore, 41 barrels, with a total of 206 barrels. It will be noted that there was a slight alternation in the amounts, with production the third and last years equal to the average for the operation. A significant result was the subsequent death of only 2 per cent of the trees from dry-facing. Private operations in the same locality using the ordinary old-time system commonly lose from 10 to 20 per cent of their timber and the average yield of gum obtained is approximately as follows: First year, 46 barrels; second year, 38 barrels; third year, 25 barrels; average yearly, 36.3 barrels.

This total yield of 109 barrels in three seasons' working with an average yearly production of 36.3 barrels per crop stands in bold contrast to the result of 206 barrels obtained under similar conditions on the National Forest by the use of better methods.

SUGGESTED SYSTEMS OF TURPENTINING.

A method that is now being tried out on the Florida National Forest in fully stocked second-growth stands starts with the gradual

[6] "Relation of Light Chipping to the Commercial Yield of Naval Stores," by Dr. Charles F. Herty. Forest Service Bulletin 90. For sale by Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 10 cents.

thinning out of the stand by means of periodic turpentining of the trees to be removed in order to develop an open forest of large-topped, vigorous trees capable of being worked for turpentine repeatedly over a period of 30 to 50 years or more.[7]

Beginning when the trees are 25 to 35 years old, the first step is the removal of the least desirable trees from the stand. These trees, perhaps one-third of the total number, are worked for turpentine under such a system of cupping as will give the maximum immediate financial returns to the operator. When the turpentine value of the tree is gone—probably after a working period of five years—they are cut and utilized. Following the working and cutting of the first lot of trees the remaining stand is again gone over at an age of 30 to 40 years, and the largest trees are selected and designated to constitute the final stand. All other trees are marked for immediate and rapid working under the system of cupping used in the first thinning operation. After five or more years of operation these trees are cut and removed from the stand. This leaves the trees of the final stand which are to receive the conservative turpentine management and from which the chief and sustained money yield of the forest is to be expected.

The final stand consists of only the best trees—those stimulated by the previous thinnings to a state of development much in advance of trees of the same age, 35 to 45 years—in unthinned stands. They should be uniformly and widely spaced and stand 50 to 100 trees per acre. The final stand is now ready for systematic working over a period of 35 to 40 years. The trees are worked conservatively, regular intervals of 3 to 5 years being allowed for rest between the successive 7 or 8 year periods of working up a face. As the tree grows and the wounds heal, narrow faces may be worked between the old ones. At the end of the "rotation," when the trees are considered mature, or at an age of about 80 years, they are heavily worked and then cut for lumber or other products.

This system is quite similar to that in use by the French in turpentining their forests of maritime pine.[8] The results of five years' operation on the Florida National Forest indicate that no great difficulty will be found in applying it generally to second-growth stands in this country.

A modification of the above method, which is believed by some practical operators to be feasible and promising, follows more nearly the prevailing custom of turpentining in that the operation starts when the largest trees in the stand have attained sufficient size for

[7] Initiated by Mr. I. F. Eldredge, forest inspector, and for about 10 years carried on under his direction. This applies to all of the turpentining operations on the Florida National Forest from 1907 to 1917.

[8] For brief description of the French method, see Farmers' Bulletin 1256, "Slash Pine."

Common Practices in Turpentining.

(Description of Plate IX.)

Fig. 1.—There are 240 trees per acre, of which 184 measure from 7 to 14 inches in diameter at breastheight, and 56, which are suppressed, measure from 4 to 6 inches in diameter. Some 20 trees per acre of turpentine sizes are too nearly dead from fire for cupping, and a good many trees are missing as the result of repeated burnings.

Some of the trees in this working have two faces and leave insufficient width of bars for the trees to function properly. The result is a marked reduction in the total production. If not disastrously burned, the stand will be worked for a third year. If the stand is afforded protection, the one-face and the two-face trees, which have not become dry-faced, and the two-face trees, which have not become dry-faced, after 5 to 10 years of rest and growth can be reworked. If the timber is not to be cut at the end of the first or second working, a more conservative working than here shown would have been advisable.

At 15 cents per cup for turpentine the stand is yielding the owner $28.80 per acre, and there will be a cut of some 15,000 board feet of lumber. The effect of the fires has been to deplete the stand of almost one-third of the trees which it should contain at the present time. In the picture some effects are clearly apparent. At the age of 45 years, well-stocked longleaf stands should have about 300 trees per acre all of turpentine sizes (Table 1).

On the same scale of working as here operated, these stands should afford about 400 cups per acre. At 15 cents per cup, and counting in the cups which have been lost by fire, the total return for timber rights would have been about $60, or an average yearly return for the 45-year period of about $1.35 per acre. The value of 15,000 board feet of second-growth pine, assumed to be $3 per thousand, would add $45 and bring the total average gross income up to $2.35 per acre yearly.

The operation, as it is being carried on, illustrates well the better class of second-growth stands and the way they are being worked. This one is in Baker County, Fla.

Fig. 2.—This stand of longleaf, with a little slash pine mixed, is about the same age and located near the stand shown in figure 1. It, however, was boxed, worked for three seasons, and since then has been allowed to burn over at random. The trees have been badly burned; some are gone "root and branch," leaving holes in the top soil as the only visible mark of where they formerly stood. More than one-half of the trees originally boxed have been killed or destroyed. The remaining portion in 1916 was considered of no value because it was badly burned, insect infested, and decayed. Eight or nine years had elapsed since the timber was worked. The original tree density was very good; now about four trees are left to every ten that were standing when they were boxed and worked. There are now 55 trees per acre measuring 7 inches or over in diameter. The growth of the trees, which came up in an old field, has been rapid, and the stand of relatively high value. The owner received 10 cents a cup, or from 192 cups per acre (an estimated number) $19.20 per acre, as the return on the timber for the period of 40 years of growth.

Under adequate protection during the 10 years following the first working, if the trees were back-cupped in 1919, and the timber sold at $3 per thousand feet on the stump, the profits would undoubtedly have been somewhere near four times the amount received. The treatment of this promising stand represents widespread practice, the folly of which is beginning to be widely and fully appreciated. This operation is in Baker County, Fla.

FIG. 1.—A 45-year-old longleaf pine stand in northern Florida being worked for the second season, with 192 cups on 164 trees per acre. (See description on p. 28.)

FIG. 2.—The story is told in this picture of the great waste of timber by fire that very commonly is permitted to follow turpentining. (See description on p. 28.)

FIG. 1.—For the purpose of conserving the yield of gum, this operator is hanging cups on timber that has up to this time been worked by the crude boxing method.

FIG. 2.—Effect of deep chipping on longleaf pine about 50 years old in Clinch County, Ga. In strong winds the leverage is great and the breaking point is mostly at the top of the face. By careless burning a good many of these faces have been deadened. It is known that pine timber may be worked for turpentine if done in suitable manner without causing great injury either to its value for other purposes or to its rate of growth.

working. After being completely worked the trees are cut and removed, giving space for the accelerated growth of the remaining stand. In the working the trees are bled for about 4 years (with a relatively narrow face to a height of 6 feet), followed by a rest for about 3 years. This operation is then repeated twice with a new face each time, representing in all a working period of about 20 years. If the age of the stand at the start was 30 years, it is now 50 years old. The trees are now cut and utilized, and another 20-year working period begun, making use of the larger trees of the remaining stand.

If the yearly burnings in connection with the turpentining destroys most of the young growth which starts, as seems likely, in order to secure a satisfactory reforestation of the tract, it may be necessary, in the case of either method of turpentining, to secure forest regeneration by the artificial means of seed sowing or by planting nursery-grown seedlings.

Operating old-growth timber on the Florida National Forest.— The regulations for turpentine operations on Government-owned timber on the Florida National Forest will afford suggestions to private owners desiring to work or lease their timber, under methods of operation that aim to reduce the injury and waste and maintain the production of turpentine over a maximum period of years. The enforcement of these requirements has been no obstacle to successful forest management, but rather has proved to be a great help. Competition for turpentine rights is keen among operators, and in 1919 the bids reached the high mark of $25.70 per 100 cups.

Close observation and study of the best practice of turpentining has resulted in the regulation of 1 cup on trees measuring from 10 to 15 inches, inclusive, in diameter; 2 cups on trees 16 to 24 inches; and not more than 3 cups on any tree. The location of the Forest in western Florida is in a region of deep, dry, sandy soil, where only longleaf pine and southern blackjack oak are able to maintain an existence and where the pine is mostly mature or slow growing.

The timber, however, is worked for about 14 years out of a total of 15 to 17 years. The procedure normally is about as follows, subject to minor variations depending upon conditions: Virgin crop worked for 3 years, high-face 4 years (sometimes 3); a rest period usually of 3 years (minimum of one year); back-cupping carried on for 3 years, and high-face back-cutting for 3 or 4 years. The first working is sold, or if desired, the combined first and second workings together. After the rest interval the same practice of selling the rights is used in the back cuppings. The plan is to sell the timber at the expiration of the working, which will be completed on a certain tract in about 5 years more, the present season being the eleventh since turpentine operations were begun.

An idea of the conditions to which the buyers of turpentine rights on the National Forest subscribe may be had from the following form. The bold-face type indicates the portions of the agreement that are filled in separately in each case, and the figures used represent about average conditions:

UNITED STATES DEPARTMENT OF AGRICULTURE.

FOREST SERVICE.

NAVAL STORES AGREEMENT.

We, James F. Elder and Wm. H. Johnson, partners, doing business under the firm name and style of Elder and Johnson, of ***Gracewood,*** State of ***Florida,*** hereby agree to work for naval stores certain timber in the ***Florida*** National Forest in accordance with ***our*** bid submitted in pursuance of a notice inviting bids therefor, duly given by publication. Said timber is all the ***longleaf pine*** timber not excepted under the terms of this agreement located on an area of about ***640*** acres to be definitely designated by a Forest officer before cupping begins in ***Sec. 14, T. 1 S., R. 26 W. Principal meridian,*** within the ***Florida*** National Forest, upon which area it is estimated that ***10,000*** cups, more or less, may be placed. In consideration of the granting of this privilege to ***us we*** do hereby promise to pay to the ***District Fiscal Agent*** (***Washington, D. C.***) or such other depository or officer as shall hereafter be designated, to be placed to the credit of the United States, the sum of ***Twenty-five hundred*** dollars (***$2,500***), more or less, as may be determined by actual count at the rate of ***Two hundred and fifty*** dollars ($***250***) per thousand cups ***in installments, the first of which shall be in the sum of not less than $1,000, payable on or before the date of execution of this agreement, the second in the sum of not less than $800 payable on or before February 1, 1923, and the third in the sum of the balance then remaining due on or before February 1, 1924,*** credit being given for the sums, if any, hitherto deposited with the said United States depository or officer in connection with this privilege.

And ***we*** further promise and agree to work said timber in strict accordance with the following conditions and all regulations prescribed by the Secretary of Agriculture:

1. Timber on valid claims and all timber under other contract with the Forest Service is exempt from cupping under this agreement.

2. No tree will be cupped, chipped, raked, or worked in any manner until payment has been made in accordance with the terms of this agreement.

3. Title to the product of the timber included in this agreement will remain in the United States until it has been paid for as herein prescribed and removed from the tree.

4. No timber will be cupped except that on the area designated by a Forest officer; and all timber on that area will be cupped except as herein specified.

5. No marked tree and no tree ***9*** inches or less in diameter at a point 4½ feet above the ground will be cupped; not more than one cup will be placed on trees from ***10*** inches to ***15*** inches, inclusive, in diameter; not more than two cups will be placed on trees from ***16*** inches to ***24*** inches, inclusive, in diameter, and not more than three cups will be placed on any tree.

6. The depth of streaks will not exceed ***1/2 inch,*** excluding the bark. The width of the streaks will be so regulated that not more than ***1/2 inch*** of new wood will be taken from the upper side of each streak. The faces chipped or pulled the first season will not exceed ***16*** inches in height from the shoulder of the first streak of the season to the shoulder of the last streak of the season, including both. The faces chipped or pulled in subsequent seasons will not exceed ***16*** inches in height, measured in the same way. A No. 0 or smaller hack or puller will be used for chipping or pulling. Bars or strips of bark not less than 4 inches wide in the narrowest place will be left between faces, and this width shall not be lessened as the faces progress up the tree. Where more than one face is placed on a tree, one bar between them will not exceed 8 inches in width. The first streak at the base of the face will be made at the time the apron or gutter is placed. Not more than one streak will be placed on any face during any week except during June and July, when faces may be double streaked, provided that not more than one-half inch is added to the height of the face during the week. Faces not chipped in accordance with these specifications may be marked out and the cups removed by the Forest officer.

7. A cupping system satisfactory to the Forest Supervisor will be used, and the cups and aprons or gutters will be so placed that the shoulders of the first streak will be not more than ***10*** inches distant from the bottom of the cup, and the cups first placed will be as near the ground as possible. No wood will be exposed on any tree by removing the bark below the gutter or aprons.

8. No unnecessary damage will be done to cupped trees, marked trees, or to trees below the diameter limit. Trees that are badly damaged during the life of this agreement, when such damage is due to carelessness or negligence, shall be paid for at the rate of $5 per thousand feet board measure, full scale. Trees split or windthrown because of deep incisions for raised tins will be considered as being damaged unnecessarily. The Forest Supervisor shall decide as to the presence and extent of damage.

9. No cups will be placed later than ***April 1***, 1922, without written permission from the Forest Supervisor, and all timber embraced in this agreement will be cupped before said date. The cupping will proceed with all reasonable speed.

10. Unless extension of time is granted, all timber will be chipped, dipped, and scraped, the product and all cups, aprons, gutters, and nails removed, and each cupped tree thoroughly raked to the satisfaction of the Forest officer not later than ***December 31, 1924.*** Tins will be pulled out, not chopped out.

11. No fires will be set to the timber, underbrush, or grass on the area covered by this agreement without the written permission of the authorized Forest officer, and during the time that this agreement remains in force ***we*** will, independently, do all in ***our*** power to prevent and suppress unauthorized forest fires on the said area and in its vicinity, and will require ***our*** employees and contractors to do likewise. ***We*** hereby agree, unless prevented by circumstances over which ***we*** have no control, to place ***our*** employees, contractors, and employees of contractors at the disposal of any authorized Forest officer for the purpose of fighting forest fires, with the understanding that unless the fire-fighting services are rendered on the area embraced in this agreement or on adjacent areas * * * ***we*** will be paid for such services at rates to be determined by the Forest officer in charge, which rates shall not be less than the current rates of pay prevailing in the said National Forest for services of a similar character: *Provided*, That the maximum expenditure for fire fighting without remuneration in any one calendar year, at rates of pay determined as above, will not exceed $***50;*** *and further provided*, That if ***we, our*** employees, contractors, or employees of contractors are directly or indirectly responsible for the origin of the fire, ***we*** will not be paid for services so rendered, nor will the cost of such services be included in determining said maximum expenditure for any calendar year.

It is further agreed that except in serious emergencies as determined by the Forest Supervisor ***we*** will not be required to furnish more than ***4*** men for fighting fires outside of the area above specified, and that any employees furnished will be relieved from fire fighting on such outside areas as soon as it is practicable for the Forest Supervisor to obtain other labor adequate for the protection of the National Forest.

12. All cupped trees will be raked in a workmanlike manner for the space of 2½ feet around each tree during December of each year of the life of this agreement; and, if required by the Forest officer in charge, a fire line not less than 3 feet wide in the narrowest place shall be hoed or plowed around the area covered by this agreement in such a manner as to completely isolate it from adjoining lands. Natural firebreaks such as creeks, swamps, roads, etc., may be utilized with the consent of the Forest officer in charge. These, fire lines must be made and receive the approval of the Forest officer in charge before any cups are placed the first year or new streaks made at the beginning of each subsequent year.

13. Cabins, shelter camps, telephone lines, and other improvements necessary in working the timber covered by this agreement will be constructed on National Forest land only under special-use permit.

14. If requested by the Forest Supervisor, ***we*** also agree to keep an accurate count and record of the number of barrels of gum and pounds of scrape obtained from the area covered by this agreement and to report the same upon request.

15. The United States reserves the right to sell or otherwise dispose of and remove or have removed all dead timber and uncupped living timber from the area covered by, and during the life of, this agreement: *Provided*, That the removal of such material will not, in the judgment of the Forest officer, interfere with the operations of the purchaser.

16. If during the life of this agreement cups are raised, the nails which had supported them and the gutters shall be removed within thirty days after the raising of the cups.

17. If during the life of this agreement cups and tins are placed on trees at any point other than at the base where they are first placed, a two-piece saw-tooth apron shall be used. In placing these aprons a straight edged driving blade shall be used and an incision made on each side of the face, which incision shall not exceed one-quarter (¼) of an inch in depth.

If desirable in order to allow cups to fit better, narrow chips, not more than ½ inch thick may be removed from the ridge in the center of the faces.

18. Complaints by the purchaser, arising from any action taken by a Forest officer under the terms of this agreement, will not be considered unless made in writing to the Forest Supervisor having jurisdiction, within thirty (30) days of the alleged unsatisfactory action.

The decision of the Secretary of Agriculture will be final in the interpretation of the regulations and provisions governing the sale, cupping, and removal of the product covered by this agreement.

19. All operations on the area may be suspended by the Forest officer in charge if the conditions and requirements contained in this agreement are disregarded, and failure to comply with any one of said conditions and requirements, if persisted in, will be sufficient cause for the termination of this agreement and the cancellation of all permits for other uses of the National Forest incident thereto: *Provided*, That the Forester may, upon reconsideration of the conditions existing at the date of sale and in accordance with which the terms of this agreement were fixed, and with the consent of the purchaser, terminate this agreement, but in the event of such termination the purchaser shall be liable for any damages sustained by the United States arising from the purchaser's operations hereunder.

20. No Member of, or Delegate to Congress, or Resident Commissioner, after his election or appointment, and either before or after he has qualified, and during his continuance in office, will be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained will be construed to extend to any incorporated company, where such contract or agreement

is made for the general benefit of such incorporation or company. (Section 3741, Revised Statutes, and sections 114–116, act of March 4, 1909.)

21. The term "officer in charge," wherever used in this agreement, signifies the officer of the Forest Service who shall be designated by the proper Supervisor or by the District Forester to supervise the timber operations in this sale.

22. This agreement will not be assigned in whole or in part.

23. The conditions of the sale are completely set forth in this agreement, and none of its terms can be varied or modified except in writing by the Forest officer approving the agreement or his successor or superior officer, and in accordance with the regulations of the Secretary of Agriculture. No other Forest officer has been or will be given authority for this purpose.

24. And as a further guarantee of a faithful performance of the conditions of this agreement, ***we*** deliver herewith a bond in the sum of ***$1,000***, and do further agree that all moneys paid under this agreement will, upon failure on ***our*** part to fulfill all and singular the conditions and requirements herein set forth, or made a part hereof, be retained by the United States to be applied as far as may be to the satisfaction of ***our*** obligations assumed hereunder.

Signed in duplicate this ***first*** day of ***December***, 192***1***.

Witnesses: (Corporate seal, if corporation.)

John Dorman.
Richard Rowley.

Elder and Johnson.
By James F. Elder,
A Member of Firm.

Approved at ***Pensacola, Fla.***, under the above conditions, ***December 8***, 192***1***.

W. F. Hillyer,
Forest Supervisor.

USEFUL EQUIVALENTS IN TURPENTINING.

A few equivalents and values in turpentining operations may be useful. They should be regarded only as approximate because of the variable nature of practically every stage of the industry. Although some of the factors refer only to mature timber, others seem to be equally applicable to second-growth trees, and all pertain to the industry as it is being carried on commercially.

1. The yield per tree of crude gum for one season averages from about 8 to 12 pounds per working cup or face on old-growth trees of average size. Based upon the figures in a following paragraph (4), the average yield per cup for a season is from 1 pint to 1 quart of turpentine and from 4 to 5 pounds of rosin.

2. A crop of 10,000 cups under common practice will generally yield from 30 to 45 barrels of turpentine and from 92 to 130 barrels of rosin (500 pounds each), depending upon the favorableness of the season, the size and vigor of the trees, and the method of working.

3. A gallon of spirits of turpentine weighs about $7\frac{1}{4}$ pounds, and a barrel of turpentine contains about 50 gallons.

4. Crude gum or "dip" may be assumed to contain, in round figures, an average by weight of 20 per cent of turpentine, 15 per cent of water and trash, and 65 per cent of rosin. One barrel of average crude turpentine will yield about 10 to 12 gallons of spirits of turpentine. One hundred pounds of clean gum will yield about $2\frac{1}{2}$ gallons of turpentine and 83 pounds of rosin.

5. The yield of both turpentine and rosin is notably increased by the use of the cup system as compared with the boxing method. The yield of turpentine for two similar crops under investigation for three years was 151 barrels by cupping, and by boxing 118 barrels

FIG. 1.—On one square rod, located in a natural opening in virgin timber and indicated by the four white markers, were 84 longleaf seedlings, or at the rate of 13,440 per acre. When examined in the spring these 3-year-old seedlings were beginning to show new green foliage, following a fire about two months before. (Bogulusa, Washington Parish, La.)

FIG. 2.—About 3,500 longleaf seedlings per acre, 2½ years old, growing under blackjack oak. They came up in a one-year grass cover which has since been protected. (Urania, La Salle Parish, La.)

FIG. 1.—Plenty of seed trees were left—the trees left were considered as culls when lumbered (1902), but unfortunately no protection against annual fires and hogs has been afforded. The result, after 15 years, is the absence of a young forest and the loss of considerable old timber by action of fire, insects, diseases, and wind. This condition apparently has misled many people to believe that longleaf land would never come back to timber.

FIG. 2.—Seed trees and protection on longleaf cut-over lands near-by that shown in Figure 1. The young forest of mixed longleaf and shirtleaf pines is growing well and producing from 1 to 2 cords yearly of wood suitable for pulpwood or 300 to 500 board feet of saw timber. The seed trees have been making profitable growth as shown on page 11. More trees were left than necessary for seed, but all were considered culls when logged.

SEED TREES AND PROTECTION—THE ESSENTIALS FOR KEEPING THE FOREST PRODUCTIVE.

of spirits of turpentine. (Pl. X.) Both shallow and light chipping, as practiced on the Florida National Forest, are effective in increasing the yield of gum.

6. If the yield for the first year is assumed to be 100 per cent, the yields for the following years in per cents for a number of crops were for turpentine 91.6, 70.6, and 62.2, and for rosin 93.8, 74.4, and 69.7, respectively.

7. If the total yield from three years' operation is assumed to be 100 per cent, turpentine operators count on obtaining about 45 per cent the first year, 35 per cent the second, and 20 per cent the third year.

A publication of the Department of Agriculture entitled "Turpentine, its sources, properties, uses, transportation, and marketing, with recommended specifications" (Agriculture Bulletin 898, 1920), may be obtained upon application to the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 15 cents.

EFFECT OF TURPENTINING TIMBER.

It is generally recognized that turpentining longleaf as commonly practiced renders the tree very liable to subsequent attack and injury by insects and various fungi, to being felled by wind (Pl. X), and particularly to severe injury by fires. However, if turpentining operations have been carefully conducted by limiting the number of faces per tree and the depth of chipping, and if adequate protection has been given, the amount of timber in any way injuriously affected has been shown to be very small; in one large operation in central Alabama it was only about 1 per cent of the total stand.

On the Florida National Forest a study was made, at the close of the third year of working, of several sections of longleaf pine located on private lands and adjoining portions of the National Forest. There had been a severe drought during the working season immediately preceding, and the casual observation of a marked difference in losses of timber suggested the study. On the timber that had been worked under Government regulations the losses were found to be about 10 per cent of the total volume of timber, whereas on the privately operated timber losses were found ranging from 25 to 60 per cent. Natural causes, such as insects, diseases, winds, and lightning, were found to have produced about 4 per cent of the losses. Thus the result of turpentining was, roundly, a loss of 6 per cent on Government-operated timber and from 20 to 55 per cent on private workings.

The mechanical properties of the wood are not affected by turpentining operations. It may be of interest to know that as far back as 1895 this subject was studied and it was reported that tests and

examinations permit of the announcement without reserve that the timber of longleaf pine is in no way affected by the tapping for turpentine. It is further pointed out that in this statement the chemical as well as the mechanical properties are considered, and thus all doubt as to the comparative durability of timber from bled and unbled trees is eliminated.

Preliminary studies of the effect of turpentining upon second-growth longleaf pine indicate, as a result, some check in the rate of growth for an indefinite period of perhaps two to four years following operations, depending on the severity of the bleeding of the tree. Locally near the face, growth takes place rapidly on account of an apparent effort of the tree to heel the wound, making very favorable conditions of the wood for later working. Additional information on this particular phase of growth is much needed.

CUTTING.

Thrifty, well-stocked stands of longleaf soon become overcrowded, and a great competition arises among the trees, the foliage seeking for light and the roots for soil moisture. This should be closely looked after by the owner. Longleaf does not readily thin itself by the natural dying-out process, but many of the smaller trees may live years in a practically dormant condition. The stronger trees gradually crowd and kill the weaker individuals. If such timber is left unthinned, big losses may be expected in the potential timber-producing power of the stand.

With some kinds of trees and forests it is more profitable if the largest trees are cut and the smaller ones are allowed to grow and take the places of those that have been cut. This system, however, is not generally to be recommended for longleaf pine. The method of cutting believed to be most applicable to longleaf consists in thinning from the bottom upward, that is, in removing first the less thrifty, overtopped, diseased, and unpromising trees. In crowded groups, good-sized trees should sometimes be removed. The cooler part of the year affords the only reason that is safe against dangerous insect menace following cutting operations. (See under "Insects, Disease, and Wind.") Such thinnings should be made as needed, usually at intervals of 5 to 10 years, each helping in the development of the final stand. The purpose of thinning is very much the same as that of the farmer in chopping his cotton or corn, namely, to give the remaining plants proper growing space and to secure the largest amount of the desired product. Trees growing wide apart in understocked stands may not need more than one thinning or they may not need any. If young longleaf stands contain undesirable kinds of trees, such as slow-growing, wide-spreading gums

or oaks, which shade out a lot of pines and promise less valuable timber, these should be cut out much as weeds are eradicated from fields. This process, known as "cleaning," may not be necessary more than once. The last thinning is followed, at a suitable age and development of the trees, by a clean cutting of the stand. The clean-cutting method is recommended for longleaf, because this species grows naturally, and probably best, in pure stands or mixed with small amounts of other pines. Longleaf, apparently, grows fastest into timber when it comes up uniformly over the land and is kept at uniform heights, for it is a species that needs an abundance of light, and hence must not be shaded by taller trees.

The desired number of trees per acre for a given stand is determined largely by the quality of the locality or the favorableness of the situation, and by the size and age of the trees. It is, after all, more a matter of judgment and experience than of rule. (See Table 1.) In the earlier thinnings, when the stand is about 20 years old, sometimes as many as one-fifth to one-third of the trees should be removed. These usually represent, however, less than one-fifth of the total timber volume of the stand.

The final clean cutting of the stand should include provisions for early restocking of the land before oaks and other inferior growth get a footing. A good way to do this is to leave seed trees. These should be the vigorous, full topped, or limby trees, of less value for lumber. In practically all stands they may be found growing alone in openings, and hence are well rooted and wind firm against the storms that may follow the cutting. It is well to spot the trees with white paint before cutting operations are begun, as is being done in some operations in the South. Certain State laws require this, as pointed out under "A seed-tree law." It is sometimes good practice to cut to a diameter limit, as, for example, down to 12 inches. In this way trees below good merchantable size will be left on the ground to aid in reseeding the land and to provide good material for cutting 5 to 10 years later. In logging timber, often no profit but a positive loss is incurred by trying to handle trees too small in size. Good forestry in lumbering operations calls for preserving the young and thrifty trees.

The amount of material secured from the several thinnings required in well-stocked stands up to an age of 50 to 70 years might easily be equivalent to one-third of the total amount yielded at the final cutting of the stand. The value of the timber, of course, would depend upon its location with reference to transportation facilities and upon the competition from outside markets. Wherever possible the trees to be removed in thinnings should first be worked for turpentine, because at times the gum brings more than would be realized

from the later sale of the timber. The progress of good roads is rapid, and it requires only a relatively short sight to anticipate the day when one's young pine will come into its own and have a very real value on the stump. With the higher prices that are being paid for all forest products, including lumber, crossties, poles, piling, fuel wood, paper pulpwood, and turpentine rights, the proper disposal of young timber is well worth looking after and should offer more than pay for the cutting.

REFORESTATION.

One often hears it said that the land will never come back to pine. To a great degree this statement has been justified, and it will be true so long as the prevailing practice continues and the prevailing sentiment maintains that the woods "just will burn and must burn." Getting young longleaf started, however, is not a serious problem. The bulk of the cut-over land has some seed-bearing trees; throughout much of the South there is probably a sufficient number of seed trees. Contrary to the general belief, cut-over longleaf lands have at rather frequent intervals become well stocked with seedling stands, each in turn of relatively short duration, because of agencies mostly of man's making and mostly under his control. Fire and native hogs have been the undoing of young longleaf pine. Reforestation thus becomes largely a matter of educating people as to the destructive nature of fire and hogs and as to methods of providing the necessary protection. The reforestation of lands from which all longleaf trees capable of bearing seed have been removed involves the necessity of starting young growth by artificially sowing seed or by planting small seedlings. Both the natural and artificial methods will be briefly considered.

SEED PRODUCTION AND GERMINATION.

Longleaf trees bear seeds at intervals of two to four years. In stands some seed is borne almost every year. Apparently about every seven years heavy crops of seed are produced generally over the longleaf belt. Such heavy seed years occurred in 1913 and 1920, and a fair crop was borne in 1916. Incidentally, the production of a heavy crop of seed is accompanied by a shrinkage in the flow of gum in turpentine operations. An experienced operator, in charge of one of the largest and most up-to-date turpentine plants in the South, estimated that the shrinkage of crude turpentine production in 1920, coincident with the maturing of the heavy seed crop, amounted to 10 to 15 per cent of the normal production.

The seeds are relatively large, averaging about 7,500 to the pound, and rich in food materials. The seeds are provided with wings which

usually carry them away from the tree for distances up to once or twice its height, and in strong winds as far as several hundred yards. Compared with the seed of most of the yellow pines, that of the longleaf is heavy and not widely dispersed. A reliable observation was reported in the fall of 1920 of an abundant seeding taking place on the leeward side of old timber at a distance of about one-quarter mile from the margin.

Like all pines longleaf requires two growing seasons to mature its seed. The seed ripens in September and soon falls from the cones. The normal time for germination is probably from two to five weeks after the seed falls, or during October and November. The seed possesses quick germinative energy and has been known to sprout in damp weather while it is in the partially closed cones on cut trees, and frequently while it is in cones lying on the ground. Seed collected in Florida in the fall of 1920 gave a germinative test of 5 per cent in 5 days, 32 per cent in 7 days, 71 per cent in 2 weeks, and 73 per cent in 17 days. Probably about 70 per cent of the seed good or viable is representative for the better grades, and about 50 per cent is the usual average. No other species of pine, so far as known, shows quicker activity in seed germination and the establishment of the seedlings (fig. 4).

SEED-TREE METHOD—NATURE'S WAY.

If proper methods are followed at the time of cutting, and if a few good seed trees are left per acre, not a dollar need be spent for seed to start young longleaf. In order that the seedling may get a good start, it is necessary for the seed to come in contact with or close to mineral soil. In low ground, where the soil cover is very heavy ("rough") and contains more than a year's growth, this is not apt to happen. The necessity then arises of preparing the ground to receive the seed. Observations show that even in deep grass a few seeds fall in openings and germinate successfully. In some cases it may be found advisable, during the winter or early spring before a good seed crop is anticipated, to burn over lands which it is desired to reforest. This will afford a light grass cover which is probably more favorable to successful germination than entirely bare soil, such as the seed would fall upon directly after the burning. Where fires have been of yearly occurrence and in regions of thin grass or other sparse soil cover, such measures will be unnecessary. The preparation of a good seed bed might be tried experimentally by turning in hogs early in the fall of a seed year, but excluding them in time to be sure of a sufficient supply of seed on the area. Natural stands up to 20,000 seedlings per acre in the spring after the heavy seed crop of 1920 were not uncommon on the Florida National Forest. On adjacent lands not under Government ownership and having fewer seed trees, the young forest

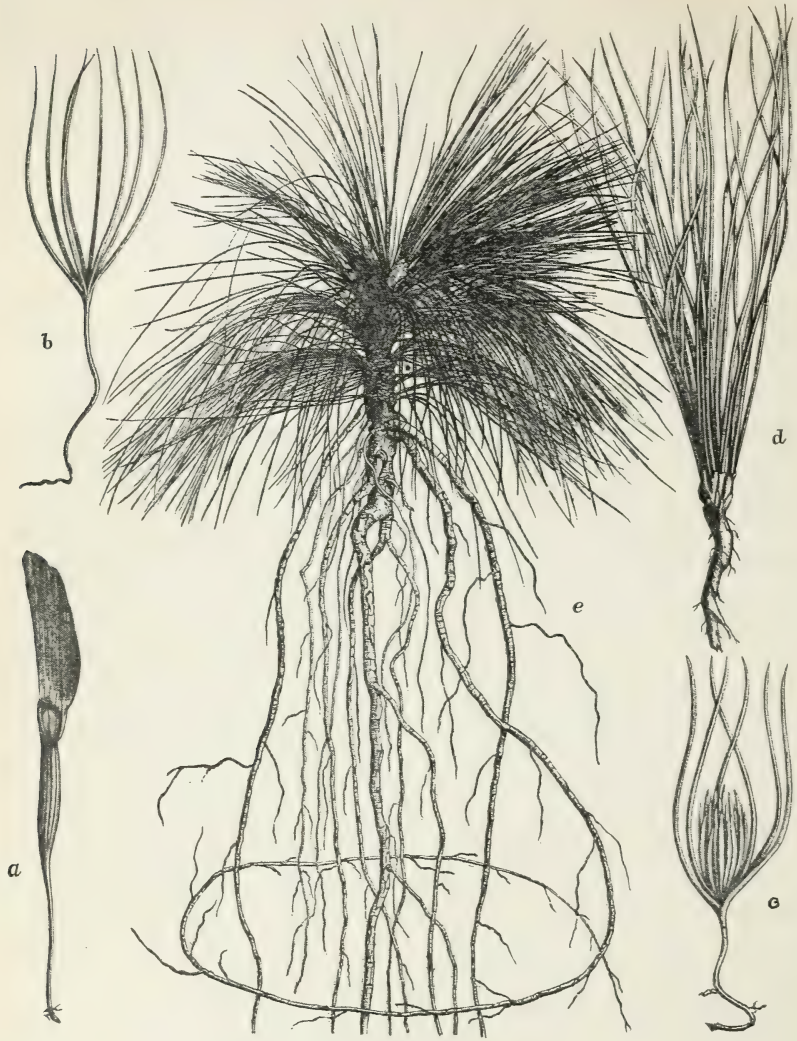


FIG. 4.—Early development of longleaf pine.

a. Seedling in October or November from 2 to 4 weeks after fall of seed.

b. Appearance a few days later, when the empty seed coat has been shed.

c. By January to March the true leaves (in sheaths with 1, 2, or 3 leaves) are expanding as shown.

d. During the first season after germination the plant develops a very short stem, above the taproot, supporting clusters of long true leaves. The early seed leaves, or cotyledons, it will be noted, have been shed.

e. A dense tuft of long, slender, drooping leaves, the whole gradually expanding and massed on a short, stout stem, gives longleaf pine its characteristic appearance during the first 3 to 5 years. It is this mass of green foliage and the so-called "asbestos" bud that enables longleaf to persist through repeated fires. Below is developed the very heavy, long tap root and strong laterals, which in other pines usually accompany saplings 2 to 6 feet in height. (From Forest Service Bulletin 13.)

was on the average only about one-fourth as dense. Stands of 4,000 to 13,000 seedlings per acre (Pl. XI) the second and third years after seeding are are not uncommon.

Although good seed years are generally followed by good stands of seedlings, it is not always so. Because of the palatability of the large kernels, great numbers of seeds are known to be destroyed by weevils, birds, mice, rats, squirrels, and razor-back hogs, and prob-

HELP REFOREST THIS TIMBERLAND

Longleaf pine bears seed in quantities only once in every 5 or 7 years.

This is a mast year, and this fall and winter will produce the only seed in quantity that can be expected before 1926 or 1927.

On the seed fall of this season depends in large part the future supply of naval stores and saw timber of this region.

The young pine seedling is quickly and totally destroyed by fire during the first two years of its life.

Nature will do its part by furnishing and sowing a bountiful supply of seed. Will you do your part in helping to prevent forest fires while the seedlings are being established?

Join us in starting a new stand of timber.

U. S. FOREST SERVICE.

Be careful with fire in the woods. If you find a fire burning, put it out if you can; if you need aid, notify the nearest Forest Ranger.

The Government on its National Forests in the South is reforesting its lands by the natural method of leaving seed trees and protecting the young growth from fires.

ably to some extent by cattle, where the seeds collect in wagon ruts and other depressions. It is believed that the practice of shooting hawks and owls has allowed the various rodent pests to multiply greatly. Favorable weather conditions during the first six months or so after the seed falls will greatly increase the number of trees that become established.

The best trees for reseeding the cut-over lands are, all things considered, the younger, full-foliaged, vigorous-growing trees.

These usually have been standing apart and are relatively very wind-firm; in favorable situations they will increase rapidly in size after the logging of the other trees. A woodsman can readily come to recognize such trees, and they should be chosen and marked by paint or other means prior to logging. If all slash is cleared away from the trees, and proper protection from fire is provided, within periods of 5 to 15 years the seed trees should provide ample young growth and be of enough value to pay all costs and a fair rate of interest on the total investment. (Pl. XII.) The probable value of the young pine stand by the twentieth year should be sufficient to offset and justify the whole cost of producing the trees, including the holding of the land. In general, seed trees of

If cut-over lands have been properly logged, and if seed trees have been left in the operation and been given adequate fire protection, the lands will become reforested naturally and the planting of seed will not be necessary.

There are many millions of acres of southern pine lands which have been cut so heavily or burned over so often and so completely that they can not become restocked naturally, and will therefore lie idle unless they are artificially reforested by the sowing of seed or the planting of seedlings.

If these lands were restored to timber production and were given adequate fire protection they would produce yearly from 100 to 400 board feet per acre of longleaf pine.

the right kind should cause no loss but rather prove to be a good investment.

A seed-tree law.—As a step in the development of sound forest principles, the State of Louisiana in 1920 enacted a seed-tree law. It is required that at least one seed tree per acre be left on lands cut by any individual or company, unless such land is agricultural in character and will be used for that purpose. A seed tree has since been defined as a "sound tree of well-developed crown and not less than 8 inches in diameter at 2 feet above the ground." The law covers just about the minimum requirement in this respect. It is better if at least three to five such trees per acre are left. The purpose of the law is to prevent complete denudation of forest land and yet work no hardship upon the owners. Some chance, at least,

FIG. 1.—The simple manner of sowing longleaf pine broadcast as conducted in the fall of 1920 by large holders of cut-over lands in Louisiana. The seed carried in sacks and sown at the rate of 2 to 4 pounds per acre. The cost was $1.50 for the seed (3 pounds) and 15 cents for the sowing, or a total of $1.65 per acre. The grass has been previously burned off. Experiments, however, have not yet progressed to a point which warrant definite recommendations regarding the best conditions of grass cover and methods of starting young longleaf forests.

FIG. 2.—A part of the 4,000 pounds of longleaf pine seed collected from the heavy seed crop of 1920 by a large sawmill company in southeastern Louisiana. The seeds were shaken from cones ("burrs"), that had opened on the ground in clear, dry weather, into pans, and brought in and sold by the collectors at 50 cents a pound. The large membranous wings are easily removed from the seed by a rubbing or beating process.

FIG. 1.—A longleaf pine plantation in southwestern Louisiana, about 14 years old. Small seedlings 3 or 4 years old were dug up in the woods and set out in rows 8 years ago. This planting was made by the head of a big sawmill plant, who doubtless foresaw the time when public sentiment would call for putting the idle cut-over lands to work and making them financially productive. (Beauregard Parish, La.)

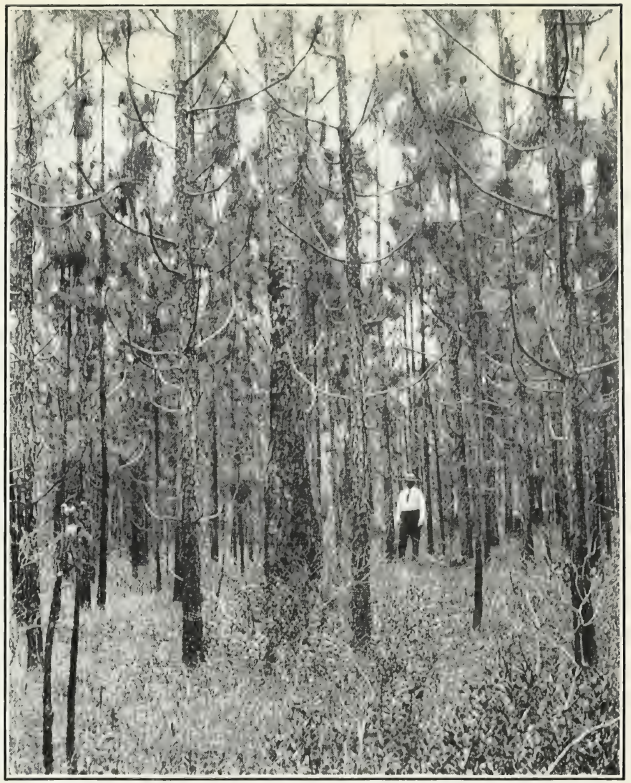


FIG. 2.—This tract of cut-over land in southeastern Texas is the result of a definite plan of the owner to get the land producing timber and grazing. The condition of the forest and range within are shown after about 14 years of protection. A "cull" tree, left in logging about 15 years before, which has since acted as a seed tree, stands near the center. The owner values highly the range for his cattle and hogs and the promising young longleaf forest. (Hardin County, Tex.)

will be afforded of cut-over lands being reforested naturally instead of remaining idle unless they are restocked by artificial seeding or planting (Pl. II).

Example of leaving seed trees.—On its own initiative a large lumber company in southeastern Louisiana is going further than required by law, and is leaving and protecting practically all small trees. The skidding crews are required to save as many small trees as they can and to throw all slash from the bases of these trees. A considerable space around the trees is raked and the wounds are painted over. In addition to relying on these groups of the smaller trees, single trees of moderate size and heavy tops which stand isolated are being left for seed, wherever needed. These are selected and ringed with paint in advance of cutting or turpentining.

It is believed that these measures will prove sound from a business standpoint. The plan does not put much value at risk, and the total cost, including the stumpage, is probably 15 to 20 cents per acre. In themselves the seed trees are likely to prove a good investment, on account of their accelerated growth, and in addition there is the enhanced value of the land that contains a good young forest stand. The leaving of very old longleaf trees for seed production has resulted in some losses, because the trees have either died standing or been blown down. Of those that died, some were killed by lightning and some by certain insects[9] which do extensive injury over much of the South.

SOWING AND PLANTING.

Available information may indicate the best lines to follow in making denuded lands produce an income. Apparently the best time for artificial seed sowing is soon after the seed matures—during October or early November. If sown much later, it probably remains dormant until the coming of warm weather. Meanwhile, the menace is great from the numerous enemies. Hence, if not sown by November, the seed should be put in storage in a cool place until about the time vegetation starts in the spring. The seed is rich in food elements and apparently deteriorates more rapidly than that of some other species of pine. The best method of storing pine seed is to place it in sealed containers after it is thoroughly air dried. Cold storage below freezing has also given fair results. If the seed is to be kept longer than a few months, one of these methods is recommended.

As to the preparation of the soil, plowing and harrowing have given the best results; but this method is obviously impracticable, because of the high cost. The results have generally varied with the degree of preparation of the soil.

[9] Belonging to the genus Ips. Studies have been made by the Bureau of Entomology, U. S. Department of Agriculture, to whom inquiries should be addressed.

The simplest method of sowing is to broadcast the seed over the natural grass land. From 2 to 4 pounds of seed per acre is believed to be about the right amount. After the sowing, if the land is clear enough to permit it, a spike-tooth or spring-tooth harrow should be run over it for the purpose of working the seed down to the soil. In this grass the seed will generally settle in the openings sufficiently to come close to mineral soil, and be afforded partial shade and protection against extremes of heat and moisture. A light ground cover, such as one season's growth of grass, is generally favorable to the establishment of the seedlings. A heavy covering of grass, fine leaves ("straw"), or oak litter, which might not keep the seed from germinating, would, however, prevent many of the seedlings from becoming established. Another method of sowing that has given fair results in loose, "black jack" soil, consists of drilling in the seed with an ordinary corn planter or seed drill. The drill should be low-built and strong, and preferably of the type that passes every seed in plain view of the operator. A bull-tongue or a scraper may be used, depending upon the character of the soil. A quiet, steady animal, needless to say, is desirable, on account of roots and other obstructions. The seed should be barely covered, not in excess of one-quarter of an inch. A modified and usually more expensive method wiuld be to drop and cover about 10 to 15 seed in a prepared "hill" or seed spot, using a hoe or a mattock much as in planting a garden. Several furrows may be run, and the seed may be sown broadcast over the area and brushed or harrowed in.

The aim should be to get trees growing at regular intervals of about 8 to 10 feet, or from 680 to 430 trees per acre. Because of the inevitable loss of some seed and seedlings from various causes, there will be a better chance of a good stand at, say, 10 years of age if more than 680 trees are started. Until further knowledge is available regarding methods of starting young longleaf stands, it will be desirable to make small-scale test sowings under different methods, with such variation as may seem advisable to suit local conditions, in order to determine which is most suitable for more extensive operations.

During the fall of 1920, a large sawmill concern in Louisiana collected about 4,000 pounds of seed of longleaf pine and also some seed of other species. It was obtained in part from dried cones ("burrs") picked from trees felled in logging, but mostly by the cheaper and more satisfactory method of gathering up cones that had opened on the ground after falling, and shaking the seeds out into a pan or tub. Incidentally it may be mentioned that the price paid to the collectors was 50 cents per pound. The seed was sown broadcast, part on plowed strips spaced 8 feet apart, each made up of several furrows and afterwards harrowed to work the seed in, and

part on natural and recently burned-over grass land (Pl. XIII). An average of 2 pounds of seed per acre was used for sowing the furrow strips and 2 to 3 for broadcasting on the grass land. The cost for broadcast sowing was 15 cents per pound and for drilling or harrowing 32 cents an acre. The plowing was done in the late fall by farmers hired after work became slack on the farm. The areas seeded were previously fenced against cattle and hogs, and plans were immediately made to keep fires out thereafter by means of fire lines and other protective measures.

The planting of longleaf seedlings, because of the very large taproot, is likely to be more restricted than that of most other species of pine. The possibilities in this line have not yet been fully tested. Successful experiments were conducted on a limited scale in eastern North Carolina by the Forestry Division of the North Carolina Geological Survey. These consisted in planting (or "transplanting") in the spring 5-month-old seedlings obtained from freshly gathered seed sown in a garden bed the previous October. The soil was shallow, with a firm subsoil, and this produced a taproot not more than 8 inches in length. At the same time, a limited number of 2-year-old seedlings were also planted with very good results. Among the residents of Southern Pines and Pinehurst, in the "sand-hill" region of North Carolina, it has been common practice to dig up volunteer longleaf seedlings from 1 to 4 years old and plant them about town in the winter season, and generally there has been little loss. One such plantation in Louisiana, about 14 years old, is shown in Plate XIV. After the first year or two, it is certain that the degree of care necessary for successfully planting young longleaf seedlings increases greatly, apparently to such a degree as to make operations on a commercial scale impracticable. Up to the present time the evidence points to good success from the spring planting of seedlings 4 to 5 months old, either when grown in prepared soil in garden beds or when dug up in the woods or old fields.

In general, reforestation by the method of planting seedlings should be attempted only in unfavorable situations where such cheaper methods as direct seed sowing have proven unsuccessful. Planting has the advantage of starting the trees in the locations desired, and thus, if successful, of securing an even stand at the outset. Soil preparation may always be expected to result in better growth, at least for a number of years. The degree and kind of soil preparation that can be given will vary widely with conditions. In fairly loose soil, shallow holes dug with a mattock or hoe should be sufficient. Undoubtedly a better method, which should prove practicable in light sandy soils, would be to prepare strips by plowing two or three furrows together, spacing them at desired intervals of say 8 to

10 feet, and planting the seedlings at about the same distance apart. Soil preparation, although helpful at the start, is usually not necessary for the growth of seedlings.

Blackjack oak lands.—The presence of much scrub or blackjack oak on cut-over lands is generally considered to be a great interference with the securing of a good natural reproduction of pine. Much of the oak did not "come in" after logging but was already present as stunted shrubs hardly noticeable at the time of logging. Undoubtedly the oak hinders reproduction by forming a thick layer of leaves which prevents many seeds from reaching the soil. The absence of young-growth pine, however, is often directly traceable to the absence of sufficient seed trees and to repeated fires. This type of oak occurs most commonly on dry ridges where fires are frequent and unusually severe. Young pine which gets a start, therefore, stands small chance of living against such odds, while the oaks sprout and seem to become more dense as a result of the action of the fire. If sufficient seed trees were left in logging, and young growth got started, it is likely that the hot fires would weaken or kill many of the seedlings in the first few years. A good growth of longleaf seedlings and saplings has repeatedly been observed among oak thickets (Pl. XI) in various parts of the South.

It may be found advisable to cut out some of the oak and make openings for the pine to get a start, as has been done by at least one lumber company in Louisiana. Various preparations, or "herbicides", are on the market for use in killing trees, and the Department of Agriculture, Washington, D. C., upon request furnishes information regarding their preparation and use. In oak thickets where seed trees are present in sufficient numbers, and where no fires have occurred in several years, in order to secure pine reproduction, many people believe that it may be advisable to burn over the land in the winter preceding the fall in which a good seed crop is anticipated. This will allow the seed to reach the soil. Protection against fire should thereafter be afforded. In the absence of good seed trees, at least an average of one to each acre, artificial methods of seed-sowing or the planting of seedlings must, obviously, be employed.

PROTECTION.

PROTECTION AGAINST FIRE.

Every informed and right-thinking person knows that the stopping of forest fires is the first step in the reproduction of forests. Fires in the woods have lost to the South a rich heritage amounting to many hundreds of millions of dollars. If the lumbermen had already cut every stick of the original-growth pine, but, if from the start, fires had been kept down, the South undoubtedly would today

FIG. 1.—After being protected for a period of 5 years, this longleaf pine was defoliated by fire (in February, 1917) up to a height of about 10 feet. The photograph was taken in the following April, when the new leaves were beginning to show.

FIG. 2.—The same stand as above, photographed at the close of the second season of growth (January, 1919). The tree growth was notably checked during the first year (see p. 12), because of the extra drain in completely renewing the foliage. Only the small stunted "runts," resulting from a former period of annual burning, were killed by the fire.

FIG. 1.

FIG. 2.

FIGS. 1 AND 2.—Views taken on opposite sides of a road in Jasper County, S. C. One side is burned over nearly every year, while the other is protected by a near-by farmstead and two roadways; the contrast in development and growth is probably representative for the whole longleaf pine belt. A count in the burned stand revealed the fact that the last fire had killed just one-third of the total number of trees, as shown by the white tags.

EVERY FIRE TAKES ITS TOLL.

FIG. 1.—A splendid start for a profitable piece of longleaf pine timber.

FIG. 2.—Under fire protection, young longleaf pine grows rapidly and in a comparatively short time reaches suitable sizes for turpentining, crossties, or pulpwood, and later for sawing into boards or other small dimensions. This stand is from 12 to 15 years old. Many young stands are, however, worked much too young.

RESULTS OF PROTECTION.

FIG. 1.—A small farmer in east Texas ran a hog-proof fence around a piece of some 20 acres of cut-over land near his buildings. He excluded hogs for 6 years and most of the fires for 12 years. The result, in part, is shown in the above view; a full stand of longleaf pines 25 to 35 feet high and 3 to 6 inches in diameter at breastheight. The owner regards the whole thing with much satisfaction, for he has a rich pasture for cattle and hogs and a valuable stand of pine about reaching the size of thinning by turpentining.

FIG. 2.—Part of the same cut-over tract shown above, looking in the opposite direction from the same spot; unprotected from hogs and subject to frequent fires.

be far richer in timber than it is. At best, few fires would probably have occurred, and some probably always will occur. Public sentiment in the South will some day reach the point where fires, so far as humanly possible, will be eleminated; those which do start will be attacked and brought under control, and the great area of natural forest land will be brought into productiveness.

A vast amount of longleaf pine is killed or seriously injured by fire every year. The first-year seedling is very susceptible to fire. The growing sapling is always set back or stunted when robbed of its tuft of foliage, and, as the result of repeated attacks, it weakens and dies. The few saplings that succeed in the struggle and reach pole size are usually worked early for turpentine, and within a period of 5 years thereafter most of them become a complete loss as a result of burning and the subsequent attacks of insects and diseases or of windfall.

The power of longleaf pine to withstand the effect of fire is remarkable. It is very likely that this exceptional adaptation has given the species the popular reputation of being completely immune from fire, and even of "thriving on fires" (Pl. XV). The fact that many longleaf saplings survive an ordinary burning fire is no adequate reason for implying that longleaf is immune and suffers no injury from fire. Every fire, with probably few exceptions, takes its toll in the death of a greater or less number of trees, and in addition causes much injury to practically all the others (Pl. XVI). The degree of injury varies widely with the size of the tree, the amount and dryness of the inflammable material, and velocity of the wind. In this manner promising young stands have been repeatedly wiped out from the same tract of cut-over land. A few stragglers can usually be found, giving a clue to the successive young stands that at various times have provided the land with the making of a forest.

If fire burns underneath 1 or 2 year old seedlings, they are usually killed. A quick grass fire under a stiff breeze, however, passes so rapidly that many 1-year-old seedlings may survive. If fires burn in summer or fall during dry weather, longleaf seedlings up to 8 years old are very apt to be completely wiped out. From about the second year up to the fifth year, or at heights up to about 1 foot, longleaf seedlings appear to be relatively very restant to the effects of fire. For longleaf pine the zone of greatest injury from fire is apparently from 1 to 5 feet above the ground, where the heat blanket is most intense. This corresponds to the ages of approximately 5 to 8 or sometimes 10 years.

The familar sight of stunted saplings standing alone or in small groups, huddled for protection on an upturned "clay root," or along

the edge of a swamp on cold, wet ground, or in very dry places where scarcely anything else can grow, gives evidence of the ceaseless pursuit of fires. The effect of protection upon the rate of growth, discussed under "Growth Under Fire Protection" (Pl. XVII), is very marked in contrast with the slow growth and accompanying stunted development more commonly seen.

The fire problem is great, but undoubtedly is can be solved by the organized cooperation of the private owner, the State, and the Federal Government, acting jointly in placing the responsibility and sharing the cost (fig. 5). The settling of the lands and the development of higher types of community organization will exert a helpful

FIVE YEARS OF FOREST FIRES
OVER $4,290,000 LOSS
IN GEORGIA
MORE THAN ¼ OF THE STATE'S 20 MILLION ACRES OF FOREST LANDS OF ALL CLASSES WERE BURNED OVER, WITH A LOSS OF OVER 4¼ MILLION DOLLARS. THE STATE DID NOTHING TO PREVENT THIS LOSS.
$16,000 LOSS
IN NEW YORK
LESS THAN 1% OF THE 7¼ MILLION ACRES OF FOREST LAND OF ALL CLASSES WERE BURNED OVER. THE STATE INVESTED ½ MILLION DOLLARS IN FOREST FIRE PROTECTION.
FOREST FIRE PROTECTION PAYS

FIG. 5.—Forest fire losses in Georgia and in New York.

economic influence, while the increasing scarcity of old growth and the advancing prices of lumber and turpentine will tend to interest owners to bring their cut-over lands into productiveness. Small owners are already in a position to afford a good measure of protection to the old fields, which constitute the source of their local supplies of timber, and to the cut-over lands, which afford grazing and help in keeping live stock over the winter.

RAZORBACK HOGS.

The native, or "razorback," hog is one of the greatest enemies of young longleaf pine. As an agent of destruction he probably holds next place to that of fire. In localities near settlements, where fires are infrequent, the hog easily becomes the chief factor in preventing the reforestation of longleaf. (Pl. XVIII.)

The piney-woods hog consumes large amounts of the seed, or mast; but probably his chief offense springs from his fondness for the thick, succulent bark on the taproot and lateral roots of young longleaf pines. In southeastern Texas the writer counted as many as fifty-two 2-year-old seedlings killed by hogs in 1 square rod, or at the rate of 8,320 per acre. It is likely that in the course of one day a hog often destroys as many as 200 to 400 young pines. Those from 2 to 5 years old probably suffer most, but not uncommonly saplings up to 10 years of age are killed. The spring season is the favored time for attack when the swamps are overflowed and food must be sought on the drier lands. In stripping the bark from the roots, sometimes the tops are left intact or are bitten off at the surface of the ground, and at other times the plants are pulled out of the

The question of future longleaf pine forests turns largely on controlling fires and "razorbacks." Millions of acres of young growth have been and are being destroyed by these agencies. Is the native hog worth while?

Two experimental tracts at Urania, La., after five years of protection against hogs, contained an average of 6,440 longleaf saplings per acre, as compared with an average of 8 per acre on two similar unprotected tracts.

ground. (Fig. 6 and Pl. XIX.) With the drying and hardening of the soil, or the exhaustion of the supply of trees, operations cease for the season. As a rule, a good stand of young longleaf will disappear completely in two to four seasons.

Although the "razorback" is widely and generally distributed, especially where stock laws are not enforced, the number of hogs present and the amount of damage accomplished appear to be variable, and in spite of the hog considerable young longleaf seems to get through the hog-danger period, only to go down in the losing battle with fires. No damage, so far as known, has been reported from blooded hogs, and with the passage of State-wide stock laws and the bringing of large tracts of land under farm management, the necessity for finding means for preventing damage from native hogs is lessening. In getting young longleaf stands started a good degree of protection against this class of hogs, if they are present, is very essential for at least the first five years.

INSECTS, DISEASES, AND WIND.

Various insects are known to attack longleaf pine. Damage by insects to fertile seeds, before being shed from the cone, has been reported. The southern pine beetle is well known because of the outbreaks that have occurred and in which large areas of pine timber have been killed. It seems that the remedy for preventing such losses in small operations consists chiefly in not cutting timber in the hot season; or, if some must be cut, in removing it without delay and either piling the brush and burning it in an opening or scattering it to dry out as quickly as possible. The trees infested with the beetle should be utilized at once. For information on this subject a copy of Farmers' Bulletin 1188, The Southern Pine Beetle, should be requested from the Division of Publications, U. S. Department of Agriculture; or a letter may be addressed to the Bureau of Entomology regarding this or other insect problems.

FIG. 6.—A, taproots stripped from 6 to 10 inches; B, top frequently broken off; C, seedlings pulled up with taproots usually 8 to 15 inches long, all roots stripped.

A cone-rust disease is known to be the cause of much injury in parts of Florida and some distance northward. It attacks the first-year cones and kills them after causing them to grow to an abnormal size. In parts of the palmetto region it is probable that this disease largely accounts for the scarcity of reproduction. A leaf blight is not infrequently seen defoliating small groups of seedlings before they get above the tall grass. The growth is checked but not otherwise affected.

Wind damage to longleaf pine is heavy, chiefly on turpentined timber (Pl. X); and occasionally tropical hurricanes make almost clean sweeps of timber. One of the largest sawmills in the South operated for about a year (1915–16) on such wind-thrown timber. The usual loss of old-growth timber from insects and wind is indicated by the results of the measurement of three "forties" in 1917 and of their remeasurement in 1920.[10] The timber consisted of about 30 trees per acre, averaging 560 board feet each, or 16,780 feet per

[10] The timber was located in the north-central part of Louisiana, and the measurements were made by members of the Yale Forest School.

FIG. 1.—The native piney woods hog is one of the worst enemies of longleaf pine. These 2-year-old seedlings were dug out of the ground. In the spring, when the ground is soft and available food scarce, hogs eat the thick, spongy, succulent bark around the taproot and larger laterals, thereby killing millions of seedlings annually. The saplings, about 2½ years old, during the ecurse of the meal were pulled completely cut of the ground and left in their present condition. Others had lost their tops and on some the roots were skinned and girdled without much damage to the tops.

FIG. 2.—On 1 square rod in eastern Texas, selected at random, there were found 38 longleaf seedlings recently killed by hogs, and 5 living. This is a slaughter of 6,080 per acre. The tract in east Texas was cut for logs in 1896 (20 years prior) and again cut for piling 10 years later, but hardly a young tree has escaped the hogs and fires

DESTRUCTION BY NATIVE RAZORBACK HOGS.

FIG. 1.—Cattle grazing on a farm in lower South Carolina, established on flat, cut-over longleaf "crawfish" lands. The growing of longleaf pine is to be favored, because it usually grows open enough so as not to interfere with success in live stock. The plowed furrows mark the margin of a strip that is burned yearly as a fire guard to protect young longleaf stands. (Berkeley County, S. C.)

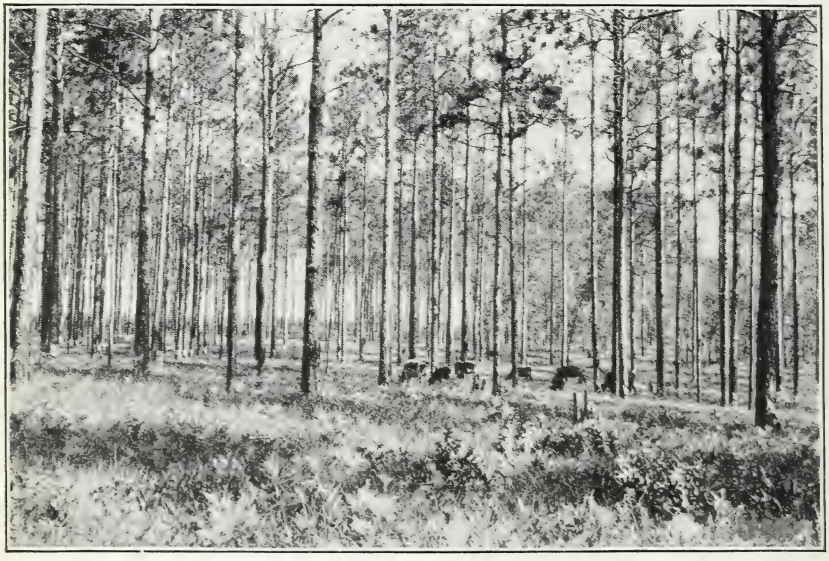


FIG. 2.—Longleaf pine stands about 40 years of age on an old field in northeastern Florida. There are about 90 trees per acre, of which about 50 are cupped for the virgin crop. The dominant trees are mostly 60 to 70 feet in height and 10 to 15 inches in diameter and would saw out about 6,000 board feet, or about one-half the yield of a well-stocked stand at this age. The land, however, has furnished continuous grazing, timber from time to time, and now about 60 cups per acre. It is being carefully worked so as not to injure the trees. (Baker County, Fla.)

FIG. 1.—Because of fires, only a very small percentage of the young trees ever reach beyond the small sapling stage. The location shown is in Louisiana, only 5 miles from a large paper-pulp mill which uses over 500 cords of wood daily, and will greatly need supplies of pulpwood within a few years.

FIG. 2.—Such timber as this, requiring from 100 to 150 years, if produced in the future will be mostly grown under State or National control rather than in private ownership. The State and Federal Governments, cooperating with the private owner, have a large and important place in any program of reforestation.

SECOND-GROWTH LONGLEAF PINE, ABOUT 40 YEARS OLD, GROWING IN A WELL-STOCKED STAND.

The trees are tall and the volume of timber per acre is large. This stand might profitably be thinned by turpentining and then cutting the trees to be removed. If no waste is permitted, such stands yield large money returns.

acre. During the 3-year period, the loss was 41 trees, mostly from 24 to 30 inches in diameter, scaling an average of 654 feet each, or an average loss of 222 board feet per acre. Most of the trees were killed by insects or blown down. Fires, which had run every year, caused the death of about 4 trees of smaller sizes. No evidence appeared of unusual wind or insect damage having been wrought.

TIMBER AND LIVE STOCK.

A large lumber company, operating exclusively in southern Mississippi and eastern Louisiana, after a general survey has estimated that about one-quarter of its cut-over lands lying mostly on the upper coastal plain soils is adapted to farming, and that the bulk of the land is better suited to other uses. The great flatwoods section, which was originally forested, chiefly with longleaf pine, offers little promise of being wanted extensively for cultivated crops. Only 10 to 15 per cent of this natural soil division and of the near-by lands is now in farms. The utilization in the near future of these nonproductive lands for timber growing and for grazing purposes is unquestionably the only logical solution of the problem (Pl. XX).[11]

> On the poorer lands no other crop promises to pay so well as timber growing.
>
> The chief sources of future economic production on the vast area of cut-over lands of the South will unquestionably be agriculture, grazing, and timber growing. The advantages for investments in the growing of pine timber in the southern region are: (1) An abundance of land of relatively low value in excess of all that can possibly be used during the next few decades for all other purposes; (2) a very long growing season, resulting in rapid timber production; (3) easy logging and shipping conditions; and (4) relative proximity to the large northern and eastern markets.

The cut-over lands of the South that are practically idle because they contain little or no forest reproduction or young growth are estimated at not less than 30,000,000 acres. Of this amount by far the greater portion consists of longleaf pine lands, an area equiva-

[11] Agriculture Bulletin 827, "The Cut-over Pine Lands of the South for Beef Cattle Production."

lent to more than all the forest lands of France. The amount of permanent "forest soil" in the South, or land which will eventually be found to be better adapted to forest purposes than to any other use, is not known, but the area is extensive. Plate XXI shows the kind of timber which, if it is grown at all in the future, will probably be produced under some form of public land control or ownership. Either acting alone or in cooperation with the Federal Government, the State after acquiring tracts of the poorer classes of southern pine cut-over lands, would doubtless be in the best position to begin building up forests for a sustained yield of turpentine and limber. Such action, if taken, would probably be more as an example to show how the thing may be done. It is believed that at the present rate of development private enterprise in the South will soon take a serious interest in managing forests of longleaf and slash pines for continuous production (Pl. XXII). Gradually the small owner will adopt the system, making such changes as may seem desirable to meet the conditions of private ownership.

There are millions of acres of lands in the Southern States which will become valuable to the owner and the State only by the growing of pine timber. The protection and reforestation of these lands mean permanent industries, permanent homes, good roads, and good schools.

While it is growing a crop of longleaf or of slash pine for turpentine and timber, much of the land at the same time can be grazed without detriment to the growth of the timber. This means of securing a double source of income is open alike to the small farmer and to the large land company. If the farmer's principal business happens to be the growing of crops, cattle and trees make a good combination for additional profit.

The best utilization of southern cut-over pine lands and the method of bringing it about constitute a problem affecting the interests of owners of farms, large landholders, the State, and the Nation. The present state of waste and idleness of these lands places a financial burden upon the owners, and, through the decrease in taxable values, upon the State and Nation.

It appears practically certain that, however large the demand may be for farming and grazing lands, vast areas of the poorer classes of land will remain idle during the next half century or more unless they are devoted to timber growing.